IMPACTS OF IRRIGATED AGRICULTURE ON WATER RESOURCES IN INDONESIA

A DISSERTATION

submitted in partial fulfillment of the requirements for the award of the degree

of

MASTER OF TECHNOLOGY

in

IRRIGATION WATER MANAGEMENT

By

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CANDIDATE'S DECLARATION

I hereby declare that the dissertation entitled **"IMPACTS OF IRRIGATED AGRICULTURE ON WATER RESOURCES IN INDONESIA"**, which is being submitted in partial fulfillment of the requirements for the award of the Degree of Master of Technology in Irrigation Water Management submitted in Departement of Water Resources Development and Management of the Indian Institute of Technology Roorkee, India is an authentic record of my work carried out during the period from July, 2010 to June, 2011 under the supervision and guidance of Prof. DR. S. K. Tripathi, Professor of the Departement of Water Resources Development and Management, Indian Institute of Technology Roorkee, India.

I have not submitted the matter embodied in this dissertation has not been submitted by me for the award of any other degree.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge and belief.

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In the name of Allah, Most Gracious, Most Merciful. All prise belong to Ållah, Lord of all the words the Gracious the Merciful. Master the day of judgement. Thee alone do we worship and Thee alone do we implòre for help. Guide us in the right path. The path of those on whom Thou hast bestowed Thy blèssings, those who have not incured Thy displeasure, and those who have not gone astray.

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SYNOPSIS

IMPACTS OF IRRIGATED AGRICULTURE ON WATER RESOURCES IN INDONESIA

Agriculture, like many other activities, can have positive and negative impacts on the environment and on water resources in particular, with consequences for human health as well as the environment. On the other word, the use of water resources by agriculture can cause quantitative resources depletion and qualitative deterioration due to overuse or misuse. Such as encroaching saltwater and salinization in coastal areas. Of the many types of compounds that can contaminate soil and water resources, those most closely associated with agriculture practices.

A part from those pollution phenomena deriving from intensive livestock rearing that produce wastes (liquid manure in particular) that could be described as point sources, the emissions of pollutants from agricultural fields are in general defined as diffuse sources (or non-point) sources. Two main categories of pollutans should be dealt with the examining the pollution of water resources from agricultural sources viz nutriens and pesticides.

Nutrients are mineral or organic compounds containing mainly nitrogen, phosporus or potassium that occure in the soils and water through natural processes (animal mannure, microbial breakdown of organic matter) and through human activities or human controlled land use practices (application of fertilizers, sewage releases, soil cultivation, livestock production).

Pesticides are synthetic organic compounds used to control weeds, insects, and other organisms, and their presence in groundwater is exclusively anthropogenic. At high concentrations in drinking water, pesticides can pose serious risk to human healt, similiar risks are posed for non mammal biota (e.g. fish) in fresh water. Releases of fertilizers and pesticides can be referred to as a direct impacts of agriculture on water resources, in the sense that the contaminants are directly introduced into the environment as agricultural inputs.

The intensity of agricultural impacts on water resources is determined by a combinations of abiotic (climate, geomorphology, etc), biotic (vegetation and fauna), and merobiotic (soil) factors. When performing an environmental impacts assessment of an agricultural system it is, therefore, important to consider the territorial context of implementation. The compatibility, or inversely the conflict of a production system with the environment is a function of the interactions between its environmental pressures and the vulnerability of the land. For the purposes of the present work, it is useful to consider these aspects (impacts, compatibility, vulnerability, etc) within the broader concept of sustainability.

Following the FAO definition as sustainable agricultural development (FAO, 1996), the perspective adopted herein is to contribute to the identification of agricultural activities able to manage and conserve water resources and to direct technological and institutional changes, ensuring the satisfaction of society's present and future water needs.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

Introduction

CHAPTER I

INTRODUCTION

1.1. Background

Agriculture, like many other activities, can have positive and negative impacts on the environment and on water resources in particular, with consequences for human health as well as the environment. On the other hand, the use of water resources by agriculture can cause quantitative resources depletion and qualitative deterioration due to overuse or misuse. Many types of compounds that can contaminate soil and water resources are those which are most closely associated with agriculture practices.

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The intensity of agricultural impacts on water resources is determined by a combinations of abiotic (climate, geomorphology, etc) and biotic (vegetation and fauna). When performing an environmental impacts assessment of an agricultural system it is, therefore, important to consider the territorial context of implementation. The conflict of a production system with the environment is a function of the interactions between its environmental pressures and the vulnerability of the land. For the purposes of the present work, it is useful to consider these aspects (impacts, compatibility, vulnerability, etc) within the broader concept of sustainability. On the other hand, impacts on water resources can be determined by water pollution, the definitions and basic classification of water pollution in general and diffuse pollution.

Water pollution, water collects impurities from the moment of its formation in the clouds. Some are harmless, other, may be offensive aesthetically or even dangerous with respect to the intended use of the water. To establish the quality of water or to compare one type of water with another, it is necessary to define a basis for evaluation and comparison. Usually, this basis is define in terms of the quality requirements for a specific beneficial use of water. The basic type of beneficial use could be defined as follows:

- ✓ Public use – domestic, commercial and institutional needs, irrigation of parks, washing of streets and other public uses.

- ✓ Industrial use – water used for specific industrial processes, including that for the main production process, and auxiliary processes such as cooling and washing of materials, equipment, floors, etc.
- ✓ Recreational use – water in lakes, reservoirs, rivers, estuaries and the ocean, used for water contact sport.
- ✓ Agricultural use – water used for irrigation of crops, pastures and other agricultural activities, and live-stock watering.
- ✓ Environmental use – water used for the propagation of fish and as a habitat for aquatic and wild life.

There are different definitions of water pollution, depending on approach and field of specialization of author, but apply this term in all cases when natural water quality has been altered in such a way that subsequent uses have became less acceptable. Ellis (1989) formulates surface water pollution as "*...the alteration in composition or condition of surface water, either directly or indirectly, as the result of the activities of men, which initiates modification of ecological system, hazard to human health and renders the stream less acceptable to downstream users.*" There are three points in this formulation, which clarify the term:

- ✓ Pollution is defined as a consequences of human activities.
- ✓ The natural water is polluted not only in the cases of public health hazard, but when the natural environment is modified.
- ✓ Pollution is an act leading to the impairment of subsequent water use for a stated purpose.

Chapter IV: Water resources condition likes rivers system and their flows, drain and their flows, water quality of streams and quality of rural and urban effluent have been explained.

Chapter V: In chapter fifth, agriculture system that are; area and production of crops, calender of operation of crops, pesticides and fertilizer use system and miscellaneous chemical use system have been described in this chapter.

Chapter VI: Pollution from agricultural activities likes as impacts on health of crops, health of animals, health of human being and impacts on atmospheric condition have been described in this chapter.

Chapter VII: Result and discussion about stream water quality, agro produce quality, human and animal health, and climate change described in chapter seventh.

Chapter VIII: Chapter eighth covering the summary, conclusion and recommendations for the impacts of irrigated agriculture on water resources described in this chapter.

CHAPTER II

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

2.1. Use of Pesticide

A pesticide is any substance or mixture of substance intended for preventing, destroying, repelling or mitigating any pest. A pesticide may be a chemical substance, biological agent (such as a virus or bacterium), antimicrobial, disinfectant or device used against any pest. Pests include insects, plant pathogens, weeds, molluscs, birds, mammals, fish, nematodes (roundworms), and microbes that destroy property, spread disease or are a vector for disease or cause a nuisance.

Although there are benefits to the use of pesticides, there are also drawbacks, such as potential toxicity to humans and other animals. FAO has defined the term of pesticide as: any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant or agent for thining fruit or preventing the premature fall of fruit, and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport.

2.1.1. History of Pesticide

Since before 20 BC, humans have utilized pesticides to protect their crops. The first known pesticide was elemental sulfur dusting used in ancient Summerians about 4,500 years ago in ancient Mesopotamia. By the 15th century, toxic chemicals such as arsenic, mercury and lead were being applied to crops to kill pests. In the 17th century, nicotine sulfate was extracted from tobacco leaves for use as an insecticide. The 19th century saw the introduction of two more natural pesticides, pyrethrum, which is derived from chrysanthemums, and rotenone, which is derived from the roots of tropical vegetables. Until the 1950s, arsenic-based pesticides were dominant.

Paul Müller discovered that DDT was a very effective insecticide. Organochlorines such as DDT were dominant, but they were replaced in the U.S. by organophosphates and carbamates by 1975. Since then, pyrethrin compounds have become the dominant insecticide. Herbicides became common in the 1960s, lead by "triazine and other nitrogen-based compounds, carboxylic acids such as 2,4-dichlorophenoxyacetic acid, and glyphosate".

In the 1940s manufacturers began to produce large amounts of synthetic pesticides and their use became widespread. Some sources consider the 1940s and 1950s to have been the start of the "pesticide era." Pesticide use has increased 50-fold since 1950 and 2.3 million tonnes (2.5 million short tons) of industrial pesticides are now used each year. Seventy-five percent of all pesticides in the world are used in developed countries, but use in developing countries is increasing. In 2001 the EPA (Environmental Protection Agency) stopped reporting pesticide use statistics; the only comprehensive study of pesticide use trends was published in 2003 by the National Science Foundation's Center for Integrated Pest Management.

In the 1960s, it was discovered that DDT was preventing many fish-eating birds from reproducing, which was a serious threat to biodiversity. The agricultural use of DDT is now banned under the Stockholm Convention on Persistent Organic Pollutants (POPs), but it is still used in some developing nations to prevent malaria and other tropical diseases by spraying on interior walls to kill or repel mosquitoes.

2.1.2. Use Pesticides in Indonesia

The development of pesticide production capacity in Indonesia increased, it is certainly in line with the needs on the field. Significant increase in production capacity occurred in the year 2003/2004 to 2007/2008 is 128.0%, from 9,128 tonnes to 20,812 tonnes. Along with the needs of the production in the 2004/2005 year period increased by 23.3% from 20,812 tonnes to 25,371 tonnes, in the year 2006/2007 increased by 30.8% from 25,371 tonnes to 33,576 tonnes and the period in 2007/2008, although the percentage decreased to 26.2%, but the capacity has increased from 33,576 tonnes to 47,369 tonnes. As shown in Table 2.1.

Table 2.1.
Growth production of Pesticides in Indonesia, 2003-2008.

S.No.	Year	Production (Ton)	Per cent (%)
1.	2003 - 2004	9,128	-
2.	2004 - 2005	20,812	128.0
3.	2005 - 2006	25,371	23.3
4.	2006 - 2007	33,576	30.8
5.	2007 - 2008	47,369	26.2

Source : Central Statistical Agency, 2009.

The value of pesticide imports during the period of 20 years on average increased by 10.75%, as in the period 1991-1992 from US$.9,066,000 to US$.12,540,000 or an increase of 14.03%, in the period 1998-1999 experienced an increase of 17.44% from US$.18,589,000 to US$.30,413,000 also increased the value of imports that occurred in the period 2007-2008 amounted to 15.41% from US$.104,040,000 to US$.160,299,000. While the value of export of pesticides during the period of 20 years on average increased by 10.69% as in the period 1988-1989 the export value increased by 18.89% from US$.7,141,000 to US$.13,529,000 the same thing increase experienced by 12.78% which occurred in the period 1995-1996 from US$.13,574,000 to US$.27,671,000 while the smallest percentage of export value occurred in the period 2001-2002 amounted to 8.22% from US$.57,577,000 to US$.59,318,000. As shown in Table 2.2.

Insectisides import value during the period of 20 years on average increased by 11.82% with the highest percentage occurred in the period 1998-1999 amounted to 27.31% from US$.1,886,000 to US$.5,150,000 that in the previous period in 1997-1998 export value decreased by 4.02% from US$.5,510,000 to US$.4,486,000. While the export value of insecticides during the period of 20 years on average increased by 10.52% with the highest percentage occurred in the period 1988-1989 amounted to 20.21% from US$.1,238,000 to US$.12,045,000 and the next period is on year 1990-1991 the export value declined significantly from US$.24,343,000 to US$.13,352,000. As shown in Table 2.2.

Imports value of fungicides during the period of 20 years increased by an average of 13.01% with the highest percentage increase in export value occurred in the period 1992-1993 that is equal to 68.45% from US$.703,000 to

US$.4,812,000 whereas the percentage decrease smallest export value occurred in the period in 1991-1992 in the amount of US$.2,881,000 to US$.703,000 or equal to 40.98%. While the export value of fungicides during the next 20 years by an average of 38.79% as in the period 2007-2008 increased by 19.88% from US$.2,626,000 to US$.5,220,000. As shown in Table 2.2.

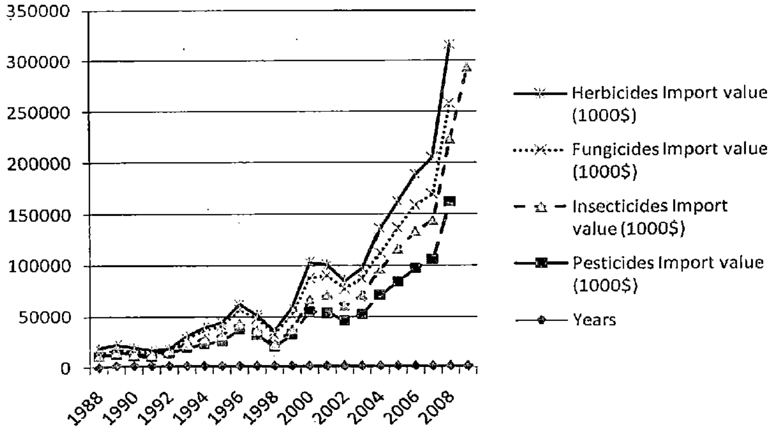
Imports value of herbicide during the period of 20 years has increased by 18.58% as it is the period 1998-1999 increased by 20.56% from US$.3,062,000 to US$.7,454,000 and in the period 2005-2006 amounted to 11.42% from US$.26,002,000 to US$.29,686,000. While the export value of herbicides during the period of 20 years on average increased by 80.35% as in the period 1996-1997 amounted to 83.29% from US$.1,512,000 to US$.12,593,000. In the periode 2006-2007 and by 17.10% from US$.32,101,000 to US$.54,907,000. As shown in Table 2.2.

Table 2.2.
Export and Import value of Pesticides, Insecticides, Fungicides and Herbicides (US$) in Indonesia, 1988-2008.

S.No.	Years	Pesticides		Insecticides		Fungicides		Herbicides	
		Import value (1000$)	Export value (1000$)	Import value (1000$)	Export value (1000$)	Import value (1000$)	Export value (1000$)	Import value (1000$)	Export value (1000$)
1	2	3	4	5	6	7	8	9	10
1	2008	160,299	135,414	60,602	66,822	35,550	5,220	57,924	58,944
2	2007	104,040	110,159	37,548	47,219	25,687	2,626	36,071	54,907
3	2006	95,136	89,889	36,178	48,091	25,525	3,002	29,686	32,101
4	2005	81,775	67,038	32,020	32,058	20,507	1,776	26,002	21,897
5	2004	69,124	64,567	24,842	33,317	16,290	1,892	23,631	19,380
6	2003	50,305	48,759	18,102	27,008	16,721	2,250	10,126	14,594
7	2002	43,946	59,318	14,191	30,647	16,693	4,034	8,270	20,350
8	2001	51,715	57,577	16,863	31,887	19,516	5,076	10,191	16,718
9	2000	53,033	70,389	11,690	32,983	20,608	5,724	15,326	29,012
10	1999	30,413	58,087	5,150	30,158	14,226	5,746	7,454	18,360
11	1998	18,589	41,822	1,886	15,131	10,079	4,838	3,062	19,285
12	1997	30,137	35,370	4,486	17,540	11,529	4,198	3,530	12,593
13	1996	35,685	27,671	5,510	19,878	13,600	5,383	5,174	1,512
14	1995	24,248	13,574	5,491	10,307	9,157	82	3,579	2,815
15	1994	20,956	10,698	5,317	10,476	7,913	66	3,180	32
16	1993	17,591	8,357	3,836	8,092	4,812	105	2,433	87
17	1992	12,540	12,167	3,058	12,049	703	84	137	3
18	1991	9,066	15,099	1,380	13,352	2,881	59	1,738	1,596
19	1990	10,052	25,518	1,196	24,343	2,718	-	3,299	1,195
20	1989	11,244	13,529	2,213	12,045	1,657	40	5,134	21
21	1988	10,660	7,141	65	1,238	2,567	-	5,368	40

Source : http://faostat.fao.org/

Fig. 2.1.
Import value of Pesticides, Insecticides, Fungicides and Herbicides in Indonesia, 1988-2008.



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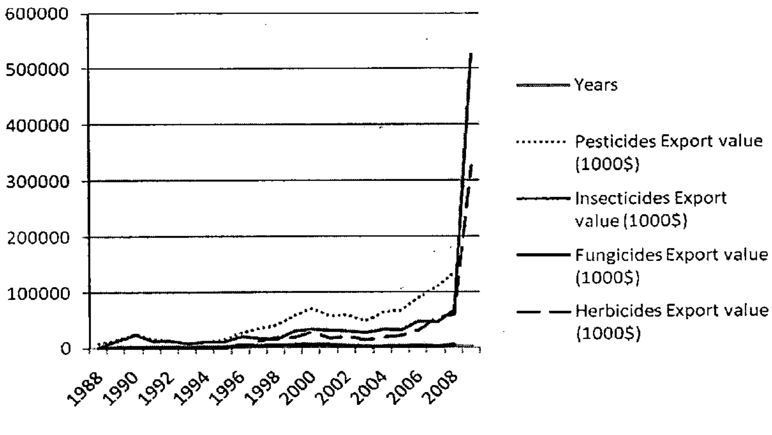
Export value of Pesticides, Insecticides, Fungicides and Herbicides in Indonesia, 1988-2008.



2.1.3. Classification/type of Pesticides

Pesticides can be classified by :

1. According to the target of control use and function.
2. According to the source.
3. According to the major chemical groups.
4. According to the formulation.
5. According to the potential risk to human health.
6. According to the type of activity.
7. According to the poisoning symtoms.

1. According to the target of control use and function.

According to Watterson (1988), there are many classification/types of pesticides on the market and continues to be used both addressed to the animals, plants and microorganisms, which control the types of insects and animals that have the potential as crop pests (*Organisme Pengganggu Tanaman*/OPT) is an insecticide, rodenticides, molusicida, avicida, and miticida. While the control microscopic organisms include bactericide, fungicide, algicida. Apart from that there are chemical compounds that are just as insect repellent (Insect Repellent), and conversely some are actually attract insects to come (Insect Attractant) and nothing can spay insects. As shown in Table 2.3.

Table 2.3.
Types of pesticides according to the target of control use and function.

S.No.	Type of Pesticide	Use and function	Targets
1.	Insecticide	For the control of insects and Chemosterilant.	Insects.
2.	Herbicide	For the control of grass or kill the grass (weeds).	Grass (Weeds).
3.	Fungicide	For the control of fungi and oomycetes is a very bad or kills fungi.	Microscopic Fungi.
4.	Nematicides	For the control of nematodes or killing nematodes.	Nematodes causing plant diseases.
5.	Rodenticides	For the control of rodents or killing rats.	Rodents; rat, mouse.
6.	Bactericides	For the control of bacteria killing bacteria.	Bacteria.
7.	Acaricides	For the control of spider or kill the spider.	Spider.
8.	Algicides	For the control of algae or killing algae.	Algae.
9.	Miticides	For the control of mites or killing mites.	Mites.
10.	Mollucicides	For the control of slugs and snails or killing mollusca.	Terrestrial molluscs; snail, slug.
11.	Avicides	For the control of birds.	Birds.
12.	Piscicides	For the control of fish.	Fish; white sucker
13.	Virucides	For the control of viruses .	Viruses.
14.	Ovicides	Destroying eggs.	Eggs.
15.	Desinfectant	Destroy harmful microorganisms or inactivation.	Microorganisms.
16.	Growth regulator	Stimulates / inhibits growth.	
17.	Desiccant	Accelerate the drying plant.	
18.	Repellent	Repel of insects, termites, dogs and cats.	Dogs, cats.
19.	Atractant	Sterilization of insects.	Insects.

Source: Watterson (1988).

2. According to the source.

The source of pesticides are humans. Large scale production of synthetic pesticides and another sources produced by natural from animal or plant of part.

Table 2.4. Types of pesticides according to the source.

S.No.	Type of Pesticides	Source
1.	Synthetic pesticides	Chemicals manufactured by humans, they do not occur in nature. Specifically in major chemical groups.
2.	Organic pesticides	Produced from animal or plant parts.

3. According to the major chemical groups.

A chemical group is formed with pesticides which have a similar chemical structure.

Table 2.5. Types of pesticides according to the major chemical groups.

S.No.	Type of Pesticides	Affects
1.	Organophosphates	Disturb of the central nervous system (brain) and peripheral nervous system (nerves found outside of the brain or spinal cord). Organophosphates attach themselves to the enzyme (acetylcholinesterase-AChE) that stops nerve transmission. Therefore, there is suppression of AChE and continuous electrical nerve transmission. This particularly affects the muscles, glands and smooth muscles that make the body organs function. General central nervous system: o Fatigue o Dizziness o Headache o Hand tremors o Staggering gait o Convulsions o Loss of consciousness o Coma From muscle over stimulation: o Muscle weakness o Muscle cramps o Twitching eyelids From gland over stimulation: o Salivary gland- excessive salivation o Sweat gland- excessive sweating o Lacrimal gland-excessive eye tearing From organ over-stimulation: o Eyes ; Blurred vision (constricted pupils) o Gastrointestinal; Stomach cramps o Nausea o Vomiting o Diarrhea o Pulmonary (Lungs); Chest tightness

		o Wheezing o Cough o Runny nose
2.	Carbamates	Carbamates behave the same way as the organophosphates in that they suppress AChE, and cause over-stimulation of the nerves. The effect comes on sooner after exposure (as fast as 15 minutes) and does not last as long (3 hours). Symptoms are the same with the exception of these symptoms below which are rare: o Convulsions o Loss of consciousness o Coma
3.	Organochlorines	Disturb the central nervous system. They are absorbed by fat so they can stay in the body a long time. As the fats cells in breast tissue can store organochlorines, it can measured in breast milk. The effects can occur within one hour after absorption and acute effects can last up to 48 hours. Some organochlorines (endosulfan) are rapidly and easily absorbed through the skin. The nerves stimulating glands are not affected so you will not see: o excessive salivation o excessive sweating o excessive eye tearing o over-stimulation of small muscles like twitching eyelids That are from disruption of central nervous: o Muscle Weakness o Dizziness o Headache o Numbness o Nausea o Loss of consciousness o Convulsions o Vomiting o Hand tremors o Staggering gait o Anxiety/restlessness o Confusion
4.	Pyrethroids	Pyrethroids are irritants to the eyes, skin and respiratory tract. The symptoms last from 1-2 hours. The symptoms from spraying can be: Normal use: o Numbness (hypersensitivity of skin) o Shortness of breath (wheezing) o Dry throat o Sore Throat o Burning nose o Skin itching If ingested: o Loss of consciousness/coma o Convulsions High doses:

		o Vomiting o Diarrhea o Excessive saliva o Twitching eyelids o Staggering gait o Irritability
5.	Thiocarbamates	Thiocarbamates are similar to the pyrethroids in that they also are irritants to the eyes, skin and respiratory tract. The symptoms can appear immediately when spraying and can be: Respiratory tract: o Dry throat o Sore Throat o Burning nose o Cough Eyes: o Eye irritation (burning, itching) o Red eyes Skin: o Skin itching o White spots on skin o Scaling skin rash o Red rash
6.	Paraquat	Paraquat is very toxic to the skin and mucous membranes (inside of mouth, nose, eyes). Particles are too large to get deep into the lungs (manufacturer claims), but once paraquat is in the blood it collects in the lungs. If ingested (drink) it is very lethal. Symptoms can be: Skin: o dryness, cracks o erythema (redness) o blistering o ulcerations Nails: o discoloration o splitting nails o loss of nails Respiratory tract: o cough o nosebleeds o sore throat Eyes: o conjunctivitis (irritation) o ulceration, scarring, blindness Ingestion: o lung fibrosis (stiff lungs) o multi-system organ failure, specifically respiratory failure o kidney failure

4. According to the formulation.

Pesticides are available in different formulations and can be obtained under solid, liquid or gaseous form. Some pesticides are marketed as ready-to-use products, in other words they do not need any special preparation before application. On the other hand, others do need to be prepared. For example, some products may need to be mixed in exact proportions with water before application. This mixture usually called spray mixture, then applied on the undesirable organism. In this very case, preparation is diluting a concentrated product.

Formulation of pesticide, be it chemical or biological in nature, is determined by its Active Ingredient (AI-also called the active substance). Pesticide products very rarely consist of pure technical material. The AI is usually formulated with other materials and this is the product as sold, but it may be further diluted in use. Formulation improves the properties of a chemical for handling, storage, application and may substantially influence effectiveness and safety.

Formulation terminology follows a 2-letter convention: (e.g. GR: granules) listed by Crop Life International (formerly GIFAP then GCPF) in the Catalogue of Pesticide Formulation Types (Monograph 2). Other common formulations include granules (GR) and dusts (DP), although for improved safety the latter have been replaced by microgranules (MG e.g. for rice farmers in Japan). Specialist formulations are available for ultra-low volume spraying, fogging, fumigation, etc. Very occasionally, some pesticides (e.g. malathion) may be sold as technical material (TC - which is mostly AI, but also contains small quantities of, usually non-active, by-products of the manufacturing process). A particularly efficient form of pesticide dose transfer is seed treatment and specific formulations have been developed for this purpose. A number of pesticide bait formulations are available for rodent pest control, etc.

Table 2.6. Types of pesticides according to the formulation

S.No.	Types	Code	Term	Definition
1.	Liquids	KK	Combi-pack solid/ Liquid.	A solid and a liquid formulation, separately contained within one outer pack, intended for simultaneous application in a tank mix.
		KL	Combi-pack liquid/ liquid	Two liquid formulations, separately contained within one outer pack, intended for simultaneous application in a tank mix.
2.	Powders	SP	Water soluble powder	A powder formulation to be applied as a true solution of the active ingredient after dissolution in water, but which may contain insoluble inert ingredients.
		WP	Wettable powder	A powder formulation to be applied as a suspension after dispersion in water.
3.	Granules	GR	Granule	A free-flowing solid formulation of a defined granule size range ready for use.
		SG	Water soluble granule	A formulation consisting of granules to be applied as a true solution of the active ingredient after dissolution in water, but which may contain insoluble inert ingredients.
		WG	Water dispersible granules	A formulation consisting of granules to be applied after disintegration and dispersion in water.
4.	Baits	CB	Bait Concentrate	A solid or liquid intended for dilution before use as a bait.
5.	Dusts	DP	Dustable Powder	A free-flowing powder suitable for dusting.
		DS	Powder for dry seed treatment.	A powder for application in the dry state directly to the seed.
6.	Smoke generators	FU	Smoke generator	A combustible formulation, generally solid, which upon ignition releases the active ingredient(s) in the form of smoke.
7.	Ultra low volume (ULV) liquids	SU	Ultra-low volume (ULV) suspension	A suspension ready for use through ULV equipment.
		UL	Ultra-low volume (ULV) liquid	A homogeneous liquid ready for use through ULV equipment.

8.	Tablet	TB	Tablet	Pre-formed solids of uniform shape and dimensions,usually circular, with either flat or convex faces, the distance between faces being less than the diameter.
		WT	Water dispersible tablet	Formulation in the form of tablets to be used individually, to form a dispersion of the active ingredient after disintegration in water.
9.	Briquettes	BR	Briquette	Solid block designed for controlled release of active ingredient into water.
10.	Gases	GA	Gas	A gas packed in pressure bottle or pressure tank.
		GE	Gas generating product	A formulation which generates a gas by chemical reaction.

Source : Catalogue of pesticides formulation types and international coding system, (2008).

5. According to the potential risk to human health

Another way of grouping pesticides is according to the potential risk to human health. The World Health Organization (WHO) has developed the following toxicity classes for chemical pesticides:

Table 2.7. Types of pesticides according to the potential risk to human health.

S.No.	Types of Pesticides	Potential of Risk
1.	Class Ia	Extremely hazardous
2.	Class Ib	Highly hazardous
3.	Class II	Moderately hazardous
4.	Class III	Slightly hazardous
5.	Class IV	Product unlikely to present acute hazard in normal use

Source : World Heatlh Organization

6. According to the type of activity.

Herbicides, fungicides and insecticides can be designated according to their action on undesirable organisms.

Table 2.8. Types of pesticides according to the type of activity.

Herbicide	
Contact	Is active only on plant parts that are covered with it.
Systemic	Absorbed by the plant, this herbicide moves inside it.
Selective	Herbicide that destroys certain plants among those being under treatment.
Non selective	Controls all of the treated plants.
Residual	Residual A product that breaks down slowly and controls plants over a long time.
Non residual	Action ceases quickly after application and controls plants over a short time.
Fungicide	
Protective	Protects the plant prior the disease infection by preventing the latter to develop.
Eradicant	Fights a disease which has already developed.
Insecticide	
Contact	Acts when insect is in contact with the product.
Inhalation	Acts when insect inhales the product.
Ingestion	Acts when insect feeds on product.

Source : Development Durable Environment

7. According to the poisoning symtoms

Generally, the process of pesticide poisoning compounds can be observed based on the class of pesticides used in the field. This phenomenon is often found in the workers directly related to pesticides such as workers at the site and workers of manufactures who directly use the pesticide compounds against the target organism. In the class of pesticides that have active ingredients from organic chlorine such as endrin, aldrin, endosulfan, dieldrin, lindane (gamma BHC) and DDT, which can cause poisoning symptoms can include nausea, headache and could not concentrate. At high doses can occur convulsions, vomiting and respiratory resistance can occur. This is caused because the organic chlorine compounds affect the central nervous system especially the brain.

Table 2.9.
Types of pesticides according to the poisoning symptoms

Pesticides Group	The way of works	Symptoms of poisoning arising
Organic chlorine : endrin, aldrin, endosulfan (thiodan), dieldrin, lindane (gamma BHC), DDT.	Affects the central nervous system especially the brain.	Nausea, headache, unable to concentrate. At high doses can occur seizures vomiting and can occur respiratory resistance.
Organic phosphat : mevinfos (fosdrin), paration, gution, monokrotofos (azodrin), dikrotofos, fosfamidon, diklorvos (DDVP), etion, efntion, diazinon.	Inhibit enzyme activity kholinestrase.	Headache, dizziness, weakness, pupil shrinking, blurred vision and shortness of breath, nausea, vomiting, abdominal cramps and diarrhea, tightness in chest and heart rate decreased.
Carbamate: aldikarb (systemic), carbofuran (furadan), metomil (lannate), propoksur (baygon), carbaryl (sevin).	Kholinestrase inhibit enzyme activity, but the reaction is reversible and more work on the network, not in the blood/plasma.	The signs of poisoning generally slow a whole new look.
Dipiridil : paraquat, diquat and morfamquat.	Can form a bond and ephitel tissue damage of the skin, fingernails, respiratory tract and digestive tract, while the concentrated solution can cause inflammation.	Symptoms of poisoning is always slow in mind, such as stomach, nausea, vomiting and diarrhea due to irritation of the digestive tract. 48-72 hours of new symptoms such as kidney damage, such as albunuria, proteinura, hematuria, and increased creatinine lever, 72 hours-14 days there were signs of damage to the lungs.
Anticoagulant : kumarin type (warfarin), 1,3 indantion type: difasinon, difenadion (ramik).	Pesticides are quickly absorbed by the digestion of food, absorption may occur from time to 2-3 days. Kumarin ingested can be absorbed through. Both types of these pesticides.	Hematuria (bloody urine), nasal bleeding, pain in the abdominal cavity, anemia and kidney damage.
Arsenic: arsenic trioxide, potassium arsenat, and arsin arsenat acid (gases).	Inhibiting the formation of substances that are useful for coagulation/blood clotting, among others, prothrombin. Arsenic poisoning in general through the mouth although it could also be absorbed through the skin and respiratory tract.	In acute poisoning: abdominal pain, vomiting and diarrhea. In sub-acute toxicity symptoms such as headaches, dizziness and a lot of saliva out.

Source: Anonymous (1984).

On organic phosphate compounds, the symptoms can be headaches, dizziness, weakness, pupil shrinking, blurred vision, shortness of breath, nausea, vomiting, abdominal cramps, diarrhea, chest tightness and heart rate decreased. These compounds inhibit the enzyme activity kolonestrasi in the patient's body. In the carbamate, the poisoning symptoms barely visible, the process also inhibits the enzyme kolinestrase works in the body, but the reaction was reversible and more work on the network rather than in blood plasma. Entered the category of compounds that are aldikarb, carbofuran, metomil, propoksur and carbaril (Anonymous, 1984). As shown in Table 2.9.

2.1.4. Pesticides Problems

Pesticides are used to control organisms considered harmful, i.e. to kill mosquitoes that can transmit potentially deadly diseases like west nile virus, yellow fever, and malaria. They can also kill bees, wasps or ants that can cause allergic reactions. Insecticides can protect animals from illnesses that can be caused by parasites such as fleas. Pesticides can prevent sickness in humans that could be caused by mouldy food or diseased produce. Herbicides can be used to clear road side weeds, trees and brush. They can also kill invasive weeds that may cause environmental damage. Herbicides are commonly applied in ponds and lakes to control algae and plants such as water grasses that can interfere with activities like swimming and fishing and cause the water to look or smell unpleasant.

Uncontrolled pests such as termites and mould can damage structures such as houses. Pesticides are used in grocery stores and food storage facilities to manage rodents and insects that infest food such as grain. Each use of a pesticide carries some associated risk. Proper pesticide use decreases these associated risks to a level deemed acceptable by pesticide regulatory agencies such as the United States Environmental Protection Agency (EPA) and the Pest Management Regulatory Agency (PMRA) of Canada.

Pesticides can save farmers' money by preventing crop losses to insects and other pests; in the U.S., farmers get an estimated fourfold return on money they spend on pesticides. One study found that not using pesticides reduced crop yields by about 10%. Another study, conducted in 1999, found that a ban on pesticides in the United States may result in a rise of food prices, loss of jobs, and an increase in world hunger.

DDT, sprayed on the walls of houses, is an organochloride that has been used to fight malaria since the 1950s. However, since 2007 study has linked breast cancer from exposure to DDT prior to puberty. Poisoning may also occur due to use of DDT and other chlorinated hydrocarbons by entering the human food chain when animal tissues are affected.

Symptoms include nervous excitement, tremors, convulsions or death. Scientists estimate that DDT and other chemicals in the organophosphate class of pesticides have saved 7 million human lives since 1945 by preventing the transmission of diseases such as malaria, bubonic plague, sleeping sickness, and typhus. However, DDT use is not always effective, as resistance to DDT was identified in Africa as early as 1955, and by 1972 nineteen species of mosquito worldwide were resistant to DDT. A study for the World Health Organization in 2000 from Vietnam established that non-DDT malaria controls were significantly more effective than DDT use. The ecological effect of DDT on organisms is an example of bioaccumulation.

Human health has been one of the most discussed issues related to pesticide use worldwide. The possibility of intoxication can come from three sources: 1) by consuming food cultivated with agrochemicals, 2) by exposure during their application and, 3) the consumption of intoxicated species. Cunningham *et. al.* (2003) divides human health problems into two categories:

1) Short-term effects, including acute poisoning and illnesses caused by relatively high doses and accidental exposures.
2) Long-term effects of chronic exposure to low dosage.

Some suspected diseases linked to this exposure include cancer, birth defects, immunological problems and Parkinson's disease.

According to the Nations "*An estimated 1 to 5 million cases of pesticides poisoning occur every year, resulting in several thousand fatalities among agricultural workers.*" (Northoff and Williams, 2004). Pesticide toxicity depends in factors such as the route of exposure (inhaled, drank, skin contact), concentration and time exposure.

The environmental fate of all chemical substances depends on their physical and chemical characteristics. Their solubility in water, size, and physical state are all properties that determine whether a pesticide will be persistent (i.e. if it will stay in the soil, water or air) and if it will be available to organisms. Table 2.10. shown the physico-chemical properties and environmental fate of pesticides, with the information in table below, the environmental fate of pesticides may be assessed. Other important features include the mode of application (liquid, solid, aerosol), toxicity to organisms, and its concentration. Ecosystem disruption depends on these factors, so each active ingradient must be considered individually for different scenarios. Some environmental problems associated with pesticides are:

- ✓ Contamination of food with pesticides.
- ✓ Negative effects to non-target organisms.
- ✓ Bioaccumulation.
- ✓ Creation of resistant strains of plagues.

2.1.5. Regulation

In most countries, pesticides must be approved for sale and use by a government agency. Complex and costly studies must be conducted to indicate whether the material is safe to use and effective against the intended pest. During the registration process, a label is created. The label contains directions for proper use of the material. Based on acute toxicity, pesticides are assigned to a Toxicity Class.

Some pesticides are considered too hazardous for sale to the general public and are designated restricted use pesticides. Only certified applicators, who have passed an exam, may purchase or supervise the application of restricted use pesticides. Records of sales and use are required to be maintained and may be audited by government agencies charged with the enforcement of pesticide regulations.

In Europe, recent EU legislation has been approved banning the use of highly toxic pesticides including those that are carcinogenic, mutagenic or toxic to reproduction, those that are endocrine-disrupting, and those that are persistent, bioaccumulative and toxic or very persistent and very bioaccumulative (vPvB).

Table 2.10. Physico-chemical properties and environmental fate of pesticides (INE, 1996)

Properties	Implications
Water solubility	Pesticides with an aqueous solubility greater than 500 mg/L are every mobile in soil and other elements of the ecosystems. Their largest concentration is found in aquatic ecosystems. Pesticides with organophosphates are not persistent in living organisms. Pesticides with an aqueous solubility of less than 25 mg/L (organochlorides) tend to be immobilized in soils and concentrate in living organisms.
Lipid/water partition coeffcient	This coefficient directly gives information about the solubilization and distribution of a pesticide in a living organism. Pesticides with a coefficient greater than 1 (aldrin and DDT) are liposoluble and can be easily absorbed by biological membranes and accumulated in fatty tissue, thus contributing to bioaccumulation.
Vapor pressure	Pesticides with a vapor pressure greater than 19^{-3} mm Hg at 25°C are very volatile. They have great mobility and disperse towards the atmosphere. The ones with a vapor pressure between 10^{-4} and 10^{-6} mm Hg at 25°C are less mobile. Compounds with vapor pressures lower than 10^{-7} are more persitent in soils and water (i.e. herbicides and triazines).
Dissociation and ionization	When compounds solubilize, they may or may not dissociate. The ones that do not dissociate are non-ionic compounds, without charge. The ones that di are ionic and may be either cathonic (positively charge) or anionic (negatively charged). Anionic pesticides (like the phenoxyacetics) and the non-ionic are mobile in soils, while the cathonic are adsorbed in the soil, and inmobilized (such as paraquat).
Degradability	This property (by chemical, biological or photo degradation) gives information on the compounds ability to degrade and diminish its activity. Malathion, parathion and pyrethrines degrade diminishing.

Though pesticide regulations differ from country to country, pesticides and products on which they were used are traded across international borders. To deal with inconsistencies in regulations among countries, delegates to a conference of the United Nations Food and Agriculture Organization adopted an International Code of Conduct on the Distribution and Use of Pesticides in 1985 to create voluntary standards of pesticide regulation for different countries. The Code was updated in 1998 and 2002. The FAO claims that the code has raised awareness about pesticide hazards and decreased the number of countries without restrictions on pesticide use.

Two other efforts to improve regulation of international pesticide trade are the United Nations London Guidelines for the Exchange of Information on Chemicals in International Trade and the United Nations Codex Alimentarius Commission. The former seeks to implement procedures for ensuring that prior informed consent exists between countries buying and selling pesticides, while the latter seeks to create uniform standards for maximum levels of pesticide residues among participating countries. Both initiatives operate on a voluntary basis.

Reading and following label directions is required by law in countries such as the United States and in limited parts of the rest of the world. One study found pesticide self-poisoning the method of choice in one third of suicides worldwide, and recommended, among other things, more restrictions on the types of pesticides that are most harmful to humans.

Regulations of pesticide use and circulation in Indonesia

1. The Minister of Farming Regulation Letter No. 434.1/Kpts/TP.270/7/2001 and the Commission of Pesticides Regulation Year 2004 of Conditions and Manner of Pesticide Use Listing, regulates certain pesticides for limited use only (e.g.,

Ramoxone/Noxone with paraquat as its active ingredient, and Supracide/ Supretox with methidathion as its active ingredient). Limited use pesticides can only be used by persons/institutions who have had official training and who also have a license. However, these pesticides can actually be used by anyone without these official requirements. Furthermore, some of these pesticides are among the PAN Dirty Dozen (such as paraquat).

2. There are pesticides that are sold freely even though its circulation permit has been expired, or are not in the government list of licensed pesticides. This practice goes against the Minister of Farming Regulation Letter No. 280/Kpts/UM/9/1973 (Pesticides Application List and Permit Procedures) and the Minister of Farming Regulation Letter No. 473/Kpts TP.270/6/1996 on the Listing and Permit Stoppage for Use on Managing Plants.
3. The sale of locally packaged pesticides without any label is also against the Minister of Farming Regulation Letter No. 429/Kpts/TP.270/9/1973 on the Standard Conditions on Pesticides Packaging and Labeling.
4. The sale of pesticides along with other products (farming tools, cattle feed, human foods/drinks) without any partition poses a danger to the safety of human health and the environment. Without any partition, pesticides can contaminate the other products.

2.2. Use of Fertilizer

Fertilizers are soil amendments applied to promote plant growth, the main nutrients present in fertilizer are nitrogen, phosphorus, and potassium (the macronutrients) and other nutrients (micronutrients) are added in smaller amounts. Fertilizers are usually directly applied to soil, and also sprayed on leaves (foliar feeding). Fertilizers are roughly broken up between organic and inorganic fertilizer, with the main difference between the two being sourcing, and not necessarily differences in nutrient content.

Organic fertilizers and some mined inorganic fertilizers have been used for many centuries, where as chemically synthesized inorganic fertilizers were only widely developed during the industrial revolution. Increased understanding and use of fertilizers were important parts of the pre-industrial British Agricultural Revolution and the industrial green revolution of the 20^{th} century.

Fertilizers typically provide, in varying proportions:

- ✓ the three primary macronutrients; nitrogen/N, phosphorus/P, and potassium/K.
- ✓ the three secondary macronutrients; calcium/Ca, sulfur/S, magnesium/Mg.
- ✓ the micronutrients or trace minerals; boron/B, chlorine/Cl, manganese/Mn, iron/Fe, zinc/Zn, copper/Cu, molybdenum/Mo and selenium/Se.

The macronutrients are consumed in larger quantities and are present in plant tissue in quantities from 0.2% to 4.0% (on a dry matter weight basis). Micronutrients are consumed in smaller quantities and are present in plant tissue in quantities measured in parts per million (ppm), ranging from 5 to 200 ppm, or less than 0.02% dry weight.

Macronutrient fertilizers are labeled with an NPK analysis and also "N-P-K-S" in Australia. An example of labeling for the fertilizer potash is composed of 1:1 potassium to carbonate by volume, or 47:53 by weight (owing to differences in molecular weight between the potassium and carbonate). Traditional analysis of 100g of KCl would yield 60g of K_2O. The percentage yield of K_2O from the original 100g of fertilizer is the number shown on the label. A potash fertilizer would thus be labeled 0-0-60, not 0-0-52.

2.2.1. History of fertilizer

The history of fertilizer has largely shaped political, economic, and social circumstances in their traditional uses. Subsequently, there has been a radical reshaping of environmental conditions following the development of chemically synthesized fertilizers.

In the 1730s, Viscount Charles Townshend (1674–1738) first studied the improving effects of the four crop rotation system that he had observed in use in Flanders. For this he gained the nickname of Turnip Townshend.

Chemist Justus von Liebig (1803–1883) contributed greatly to the advancement in the understanding of plant nutrition. His influential works first denounced the vitalist theory of humus, arguing first the importance of ammonia, and later promoting the importance of inorganic minerals to plant nutrition. Primarily Liebig's work succeeded in exposition of questions for agricultural science to address over the next 50 years.

In England, he attempted to implement his theories commercially through a fertilizer created by treating phosphate of lime in bone meal with sulfuric acid. Although it was much less expensive than the guano that was used at the time, it failed because it was not able to be properly absorbed by crops.

At that time in England, Sir John Bennet Lawes (1814–1900) was experimenting with crops and manures at his farm at Harpenden and was able to produce a practical superphosphate in 1842 from the phosphates in rock and coprolites. Encouraged, he employed Sir Joseph Henry Gilbert, who had studied under Liebig at the University of Giessen, as director of research. To this day, the Rothamsted research station the pair founded still investigates the impact of inorganic and organic fertilizers on crop yields.

In France, Jean Baptiste Boussingault (1802–1887) pointed out that the amount of nitrogen in various kinds of fertilizers is important.

Percy Gilchrist (1851–1935) and Sidney Gilchrist Thomas (1850–1885) invented the Thomas-Gilchrist converter, which enabled the use of high phosphorus acidic Continental ores for steelmaking. The dolomite lime lining of the converter turned in time into calcium phosphate, which could be used as fertilizer, known as Thomas-phosphate.

In the early decades of the 20th Century, the Nobel prize-winning chemists Carl Bosch of IG Farben and Fritz Haber developed the process that enabled nitrogen to be synthesised cheaply into ammonia, for subsequent oxidation into nitrates and nitrites.

In 1927 Erling Johnson developed an industrial method for producing nitrophosphate, also known as the Odda process after his Odda Smelteverk of Norway. The process involved acidifying phosphate rock (from Nauru and Banaba Islands in the southern Pacific Ocean) with nitric acid to produce phosphoric acid and calcium nitrate which, once neutralized, could be used as a nitrogen fertilizer.

The Englishmen James Fison, Edward Packard, Thomas Hadfield and the Prentice brothers each founded companies in the early 19th century to create fertilizers from bone meal.

The developing sciences of chemistry and Paleontology, combined with the discovery of coprolites in commercial quantities in East Anglia, led Fisons and Packard to develop sulfuric acid and fertilizer plants at Bramford, and Snape, Suffolk in the 1850s to create superphosphates, which were shipped around the world from the port at Ipswich. By 1871 there were about 80 factories making superphosphate.

After World War I these businesses came under competitive pressure from naturally-produced guano, primarily found on the Pacific islands, as their extraction and distribution had become economically attractive. The interwar period saw innovative competition from Imperial Chemical Industries who developed synthetic ammonium sulfate in 1923, Nitro-chalk in 1927, and a more concentrated and economical fertilizer called CEF based on ammonium phosphate in 1931. Competition was limited as ICI ensured it controlled most of the world's ammonium sulfate supplies.

Other European and North American fertilizer companies developed their market share, forcing the English pioneer companies to merge, becoming Fisons, Packard, and Prentice Ltd. in 1929. Together they produced 85,000 tons of superphosphate/year in 1934 from their new factory and deep-water docks in Ipswich. By World War II they had acquired about 40 companies, including Hadfields in 1935 and two years later the large Anglo-Continental Guano Works, founded in 1917.

The post-war environment was characterized by much higher production levels as a result of the "Green Revolution" and new types of seed with increased nitrogen absorbing potential, notably the high-response varieties of maize, wheat, and rice. The original names no longer exist other than as holding companies or brand names: Fisons and ICI agrochemicals are part of today's Yara International and Astra Zeneca Companies.

Major players in this market now include the Russian Uralkali fertilizer company Uralkali (listed on the London Stock Exchange), whose majority owner is Dmitry Rybolovlev, ranked by Forbes as 60th in the list of wealthiest people in 2008.

The modern understanding of plant nutrition dates to the 19th century and the work of Justus Von Liebig, among others. Management of soil fertility, however, has been the pre-occupation of farmers for thousands of years.

2.2.2. Use of Fertilizer in Indonesia

Main producer of fertilizer in Indonesia which is a national company consisting of Pupuk Sriwijaya Co. Ltd. (PUSRI), Petrokimia Gresik Co. Ltd., Pupuk Kujang Co. Ltd., Pupuk Kalimantan Timur Co. Ltd. (KALTIM), Pupuk Iskandar Muda Co. Ltd. (PIM), and Asean Aceh Fertilizer Co. Ltd. (AAF).

Pupuk Sriwijaya, Co. Ltd. Ammonia and urea production during the period 1974-1994 Ammonia production capacity of 1,499,000 tonnes and 2,280,000 tonnes of urea. Petrokimia Gresik Co. Ltd. in the period 1972-1986 produces ZA/AS (Zinc Ammonia/Ammonium sulfate) at 650,000 tonnes, and in 1979 produced TSP/SP36 fertilizer (Triple Super Phosphate) amounted to 1,000,000 tonnes, while in 1994 production amounted to 445,000 tonnes Ammonia and Urea at 460,000 tonnes. Pupuk Kujang Co. Ltd. in 1979 to produce ammonia and urea, each for 713,000 tonnes and 1,156,000 tonnes. Pupuk KALTIM Co. Ltd. in the period 1989-2002 to produce ammonia and urea, each of which amounted to 1,848,000 tonnes and 2,980,000 tonnes.

Table 2.11.
Production capacity of fertilizer in Indonesia (ton/year).

S.No.	Manufactures	Ammonia	Urea	TSP/SP36 (Triple Super Phosphat)	ZA/AS (Zinc Ammonia/ Amonium Sulfat)
1.	Pupuk Sriwijaya, Co. Ltd.				
	1994 PUSRI II	446,000	570,000	-	-
	1974 PUSRI III	261,000	570,000	-	-
	1976 PUSRI IV	396,000	570,000	-	-
	1977 PUSRI IB	396,000	570,000	-	-
	Amount	**1,499,000**	**2,280,000**	-	-
2.	Petrokimia Gresik. Co. Ltd.				
	1994 Urea Petro	445,000	460,000	-	-
	1979 SP36 Unit I	-	-	500,000	-
	1979 SP36 Unit II	-	-	500,000	-
	1972 ZA Unit 1	-	-	-	200,000
	1984 ZA Unit 2	-	-	-	250,000
	1986 ZA Unit 3	-	-	-	200,000
	2000 Phonska	-	-	-	-
	Amount	**445,000**	**460,000**	**1,000,000**	**650,000**
3	Pupuk Kujang. Co. ltd.				
	1979 Kujang I	383,000	586,000	-	-
	1979 Kujang IB	333,000	570,000	-	-
	Amount	**713,000**	**1,156,000**	-	-
4.	Pupuk Kaltim. Co. Ltd.				
	1989 KALTIM 1	594,000	700,000	-	-
	1989 KALTIM 2	594,000	570,000	-	-
	1989 KALTIM 3	330,000	570,000	-	-
	2002 KALTIM 4	330,000	570,000	-	-
	1999 POPKA	-	570,000	-	-
	Amount	**1,848,000**	**2,980,000**	-	-
5.	Pupuk Iskandar Muda. Co, Ltd.				
	1984 PIM 1	366,000	600,000	-	-
	2005 PIM 2*)	396,000	570,000	-	-
	Amount	**762,000**	**1,170,000**	-	-
6.	Asean Association Fertilizer. Co. Ltd.				
	1983 AAF**)	396,000	660,000	-	-
	Amount	**396,000**	**660,000**	-	-
Total		**5,663,000**	**8,706,000**	**1,000,000**	**650,000**

*)During construction, commisioning and start-up estimated on 3[th] Q 2005.
**)Since 2004 the plant was closed because since 2003 AAF experience storage of natural gas supply to the plant. At the moment the status of the company still within discussion by share holder within ASEAN Governments i.e. Indonesia, Malaysia, Thailand, Philipines and Singapore.

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2007.

Meanwhile, Pupuk Iskandar Muda Co. Ltd. Ammonia and urea production in 2005 amounted to 396,000 tonnes and 570,000 tonnes. In 1983 Asean Aceh Fertilizer (AAF) produced ammonia and urea, each for 396,000 tonnes and 660,000 tonnes. As shown in Table 2.11.

The quantity of phosphate fertilizer production in the period 2002-2008 the average increased by 11.93%, a significant increase occurred in the period 2002-2003 from 254,669 tonnes to 526,620 tonnes, whereas in the period 2007-2008, an increase of 13.73% from 349,787 tonnes to 480,162 tonnes.

The quantity of imported phosphate fertilizers in the period 2002-2008 by an average of 12.44% with the highest percentage occurred in the period 2003-2004 amounted 18.38% from 74,312 tonnes to 136,590 tonnes. The export capacity of phosphate fertilizer in this period by an average of 14.58% with the highest percentage occurred in the period 2005-2006 amounted to 34.59% and lowest in the period 2004-2005 amounted to 3.53% from 925 tonnes to 1,485 tonnes. The capacity of phosphate fertilizer consumption in the period 2002-2008 by an average of 11.44% as in 2006-2007 amounted to 10.87% from 354,675 tonnes to 385,649 tonnes. As shown in Table 2.12.

Table 2.12.
Production quantity , import, export and consumption of Phosphat fertilizer in Indonesia (ton/year), 2002-2008.

Phosphate fertilizers (P_2O_5 total nutriens)				
Year	Production quantity in nutriens (tonnes of nutriens)	Import quantity in nutriens (tonnes of nutriens)	Export quantity in nutriens (tonnes of nutriens)	Consumption in nutriens (tonnes of nutriens)
2008	480,162	280,186	8,262	383,219
2007	349,787	169,524	3,778	385,049
2006	307,735	167,199	5,137	354,075
2005	345,063	109,081	1,485	327,794
2004	318,134	136,590	925	318,134
2003	526,620	74,312	2,630	526,620
2002	254,669	117,854	6,461	254,669

Source : http://faostat.fao.org/

The quantity of nitrogen fertilizer production in the period 2002-2008 an average of 10.86% per year, the highest percentage increase occurred in the period 2004-2005 amounted to 12.45% from 2,309,142 tonnes to 2,3875,658 tonnes and the lowest in the period of 2005-2006 amounted to 9.77% from 2,875,658 tonnes to 2,808,307 tonnes. The quantity of nitrogen fertilizer imports during the period 2002-2008 with an average of 10.99%, with the highest percentage occurred in the period 2007-2008 amounted to 15.09% from 2,947,267 tonnes to 3,189,117 tonnes, while the lowest occurred in the period 2003-2004 amounted to 6.98% from 139,436 tonnes to 96,678 tonnes. While the export quantity of nitrogen fertilizer in the period 2002-2008 an average of 31.16%. The consumption of nitrogen fertilizer during the period of 2002-2008 by an average of 10.69%. As shown in Table 2.13.

Table 2.13.
Production quantity, import, export and consumption of Nitrogen fertilizer in Indonesia (ton/year), 2002-2008.

Nitrogen fertilizers (N total nutriens)				
Year	Production quantity in nutriens (tonnes of nutriens)	Import quantity in nutriens (tonnes of nutriens)	Export quantity in nutriens (tonnes of nutriens)	Consumption in nutriens (tonnes of nutriens)
2008	3,189,117	237,212	89,799	2,675,620
2007	2,947,267	157,164	318,966	2,503,269
2006	2,808,307	181,157	20,819	2,435,519
2005	2,875,658	143,436	310,231	2,411,944
2004	2,309,142	96,678	199,051	2,309,142
2003	2,119,780	139,436	577,373	2,119,780
2002	1,974,661	178,925	513,723	1,974,661

Source : http://faostat.fao.org/

Potash fertilizer import quantity in the period 2002-2008 increased an average of 12.80% per year, with the highest percentage occurred in the period

2003-2004 amounted to 18.40% from 332,709 tonnes to 612,261 tonnes and the lowest percentage occurred in the period 2004-2005 9.35% from 612,261 tonnes to 572,301 tonnes. While the average Potash fertilizer consumption in the period 2002-2008 amounted to 13.24% with the highest percentage occurred in the period 2003-2004 amounted to 20.95% from 290,747 tonnes to 605,135 tonnes and the lowest percentage by 9.26% from 609,135 tonnes to 564,174 tonnes which occurred in the period 2004-2005. As shown in Table 2.14.

Table 2.14.
Production quantity, import, export and comsumption of Potash fertilizer in Indonesia (ton/year), 2002-2008.

Potash fertilizers (K_2O total nutriens)				
Year	Production quantity in nutriens (tonnes of nutriens)	Import quantity in nutriens (tonnes of nutriens)	Export quantity in nutriens (tonnes of nutriens)	Consumption in nutriens (tonnes of nutriens)
2008	-	1,175,436	2,543	1,130,750
2007	-	832,007	1	810,740
2006	-	625,525	632	607,749
2005	-	572,301	-	564,174
2004	-	612,261	-	609,135
2003	-	332,709	2,312	290,747
2002	-	311,184	6,443	259,892

Source : http://faostat.fao.org/

The development of urea production in Indonesia produced by PT PUSRI, PT Pupuk Kujang, PT Pupuk Kaltim, PT Petrokimia Gresik, PT Pupuk Iskandar Muda and PT Asean Aceh Fertilizer during the period of 45 years, the average since the year 1963-2007 increased by 13.09% per year with the lowest percentage occurred in the period 1967-1968 from 95,528 tonnes to 84,170 tonnes, while the highest percentage occurred in the period 1974-1975 amounted to 19.41% from 207,375 tonnes to 402,430 tonnes.

The capacity production of urea to PT PUSRI during the period 1963-2007 amounted to 55,185,948 tonnes with an average growth of 12.84% per year or a total of 1,226,354 tonnes/year. Urea production capacity to PT Pupuk Kujang of 16,868,115 tonnes with an average growth of 7.78% per year or a total of 374,847 tonnes/year. For a production capacity of PT Kaltim Fertilizer for 40,675,636 tonnes with an average of 6.01% per annum or a total of 903,903 tonnes/year. While PT Petrokimia Gresik of 4,404,947 tonnes with an average of 8.58% annually or a total of 97,888 tonnes/year. As for production capacity of PT Iskandar Muda Fertilizer for 11,839,099 tonnes with an average of 4.95% per annum or a total of 253,659 tonnes/year. The PT AAF production capacity of 11,414,644 tonnes with an average of 7.02% or a total of 253,659 tonnes/year. As shown in Table 2.15 and Fig. 2.3.

Fig. 2.3.
Growth average of urea fertilizer production in Indonesia per year

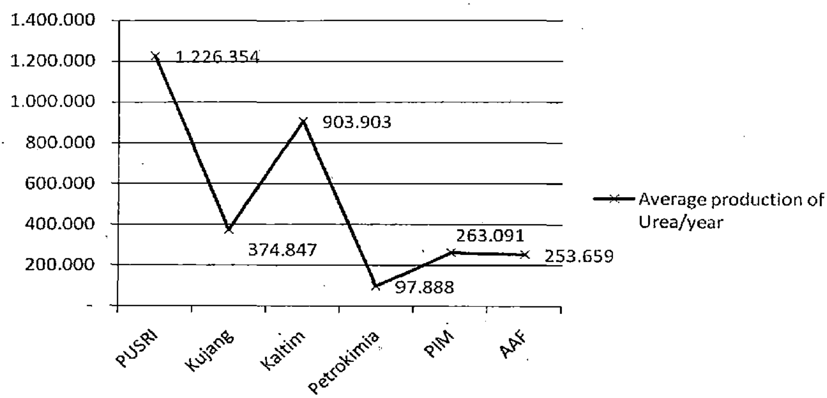


Table 2.15.
Growth of urea fertilizer production based on producer (ton), 1963-2007.

S.No.	Years	PUSRI	KUJANG	KAL TIM	PETRO KIMIA	PIM	AAF	TOTAL
1.	1963	9,723	-	-	-	-	-	9,723
2.	1964	103,547	-	-	-	-	-	103,547
3.	1965	95,120	-	-	-	-	-	95,120
4.	1966	93,015	-	-	-	-	-	93,015
5.	1967	93,337	-	-	-	-	-	93,337
6.	1968	95,527	-	-	-	-	-	95,528
7.	1969	84,170	-	-	-	-	-	84,170
8.	1970	98,407	-	-	-	-	-	98,407
9.	1971	104,750	-	-	-	-	-	104,750
10.	1972	108,222	-	-	7,830	-	-	116,052
11.	1973	108,267	-	-	13,896	-	-	122,163
12.	1974	191,064	-	-	16,311	-	-	207,385
13.	1975	389,846	-	-	12,584	-	-	402,430
14.	1976	385,950	-	-	906	-	-	386,856
15.	1977	806,565	-	-	12,487	-	-	819,052
16.	1978	1,364,042	72,316	-	14,872	-	-	1,451,230
17.	1979	1,373,295	438,027	-	13,611	-	-	1,824,933
18.	1980	1,479,296	558,131	-	6,042	-	-	2,043,469
19.	1981	1,478,190	527,271	-	15,285	-	-	2,020,746
20.	1982	1,430,011	514,104	-	5,832	-	-	1,949,947
21.	1983	1,620,608	578,311	-	6,214	-	55,800	2,260,933
22.	1984	1,638,413	577,733	140,500	-	470	548,502	2,905,618
23.	1985	1,576,592	494,094	400,261	-	565,969	548,419	3,585,335
24.	1986	1,527,737	645,538	580,412	-	636,695	629,272	4,019,654
25.	1987	1,466,712	552,098	852,768	-	588,742	572,190	4,032,510
26.	1988	1,381,326	581,590	1,017,032	-	602,256	574,580	4,156,784
27.	1989	1,473,040	562,463	1,636,732	-	596,364	591,900	4,860,499
28.	1990	1,505,075	580,901	1,712,097	-	604,800	647,659	5,050,532
29.	1991	1,571,840	561,242	1,716,440	-	581,913	541,760	4,973,195
30.	1992	1,441,795	570,127	1,710,131	-	582,908	615,310	4,920,271
31.	1993	1,477,970	585,021	1,827,607	-	583,075	659,051	5,132,724
32.	1994	1,667,480	536,325	1,815,048	153,558	568,808	547,891	5,289,110
33.	1995	2,036,760	607,803	1,713,308	368,849	600,055	567,961	5,894,735
34.	1996	2,180,780	596,425	1,849,700	300,423	619,803	652,646	6,199,777
35.	1997	2,112,990	600,769	1,856,051	400,997	639,079	695,826	6,305,712
36.	1998	2,223,456	511,115	1,833,998	286,545	636,233	663,367	6,154,714
37.	1999	1,997,260	560,142	1,904,300	271,122	550,836	685,654	5,969,314
38.	2000	1,924,820	580,030	2,237,595	341,434	664,201	586,798	6,334,878
39.	2001	2,005,250	552,646	2,104,261	313,116	217,784	122,832	5,315,889
40.	2002	2,032,680	552,984	2,081,827	151,066	586,035	601,629	6,006,221
41.	2003	2,053,410	597,597	2,023,321	260,176	491,016	305,598	5,731,118
42.	2004	2,187,550	526,899	2,272,289	344,356	336,321	-	5,667,415
43.	2005	2,045,860	537,563	2,665,021	404,364	195,847	-	5,848,655
44.	2006	2,051,250	851,579	2,214,961	331,677	205,225	-	5,654,692
45.	2007*	1,046,472	428,470	1,254,988	175,697	92,332	-	2,997,959

*Production from January to June 2007
PUSRI = Pupuk Sriwijaya; KUJANG = Pupuk Kujang; KALTIM = Pupuk Kalimantan Timur
PETROKIMIA = Pupuk Petrokimia Gresik; PIM = Pupuk Iskandar Muda
AAF = Asean Aceh Fertilizer

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2007.

Table 2.16.
Growth production of fertilizer ZA/AS, TSP/SP36 and NPK (ton/year), 1972-2007.

S.No.	Year	ZA/AS[1)]	TSP/SP36[2)]	NPK
1.	1972	29,390	-	-
2.	1973	119,623	-	-
3.	1974	121,767	-	-
4.	1975	122,471	-	-
5.	1976	75,033	-	-
6.	1977	92,371	-	-
7.	1978	141,141	-	-
8.	1979	147,855	114,336	-
9.	1980	180,773	465,018	-
10.	1981	195,345	559,151	-
11.	1982	209,609	577,386	-
12.	1983	208,021	783,616	-
13.	1984	302,127	1,001,781	-
14.	1985	475,581	1,007,070	-
15.	1986	581,648	1,116,909	-
16.	1987	260,601	1,203,607	-
17.	1988	573,842	1,200,403	-
18.	1989	633,918	1,198,445	-
19.	1990	659,817	1,279,864	-
20.	1991	542,722	1,041,802	-
21.	1992	619,662	1,248,763	-
22.	1993	541,700	1,299,000	-
23.	1994	604,800	1,160,000	-
24.	1995	642,836	809,678	-
25.	1996	663,125	1,113,965	417
26.	1997	522,948	868,389	9,885
27.	1998	324,094	616,490	297
28.	1999	510,201	728,658	1,072
29.	2000	533,231	587,988	19,638
30.	2001	515,455	654,678	63,492
31.	2002	426,965	520,855	83,011
32.	2003	479,281	687,657	113,842
33.	2004	572,599	763,225	202,000
34.	2005	644,321	819,701	274,478
35.	2006	631,645	647,868	-
36.	2007[3)]	330,181	316,361	207,424

[1)] Zwavelzure ammoniak/Ammonium sulfat.
[2)] Triple Super Phosphate.
[3)] Production on Januari - June 2007.

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2007.

The development of urea fertilizer sales in the period 1987-2005 was dominated by 5 major players such as PT. Pusri, PT. Pupuk Kujang, PT. Pupuk Kaltim, PT. Pupuk Iskandar Muda and PT. Petrokimia Gresik during this period total sales amounted to 6,744,630 tonnes with an average growth of 10.64% per annum or a total of 354,981 tonnes per annum. The capacity of the highest sales of 2,680,506 tonnes by PT Pusri with an average increase 9.71% per annum or a total of 141,079 tonnes per year, then the capacity of sales amounted to 2,476,508 tonnes with an average growth of 10.54% per annum or 130,343 tonnes per year by PT. Kaltim Fertilizer and successively by PT. Pupuk Kujang amounted to 1,098,414 tonnes with a growth of 11.59% per annum, PT. Pupuk Iskandar Muda 272,676 tonnes per year with a growth of 6.11% per year and PT. Petrokimia Gresik with sales of capacity 216,526 tonnes with an average of 11,396 tonnes per annum. As shown in Table 2.17.

Table 2.17.
Growth sale of urea fertilizer (ton), 1987-2005.

S.No.	Years	PUSRI	KUJANG	KAL TIM	PIM	PETRO KIMIA	TOTAL
1.	1987	141,649	-	-	-	-	141,649
2.	1988	201,068	-	-	-	-	201,068
3.	1989	209,581	-	3,390	-	-	212,971
4.	1990	247,051	-	-	-	-	247,051
5.	1991	119,973	1,570	100,216	9,000	-	230,759
6.	1992	122,308	2,409	138,650	15,950	-	279,317
7.	1993	137,119	3,883	159,552	18,795	-	319,349
8.	1994	124,664	16,765	116,470	19,450	12,121	289,470
9.	1995	139,232	32,738	112,045	14,860	34,850	333,735
10.	1996	127,896	35,067	121,215	21,664	37,771	343,613
11.	1997	146,307	38,488	201,631	26,950	44,530	457,906
12.	1998	156,976	43,566	223,385	24,250	30,488	478,665
13.	1999	99,699	40,186	161,734	24,325	31,736	357,680
14.	2000	93,070	141,649	243,847	6,400	-	484,966
15.	2001	117,218	201,068	112,926	925	-	432,137
16.	2002	125,504	209,581	140,608	-	-	475,793
17.	2003	101,299	118,631	180,069	51,646	-	451,645
18.	2004	139,892	112,813	60,770	13,461	30	326,966
19.	2005	130,000	100,000	400,000	20,000	25,000	675,000

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2006.

Development of fertilizer demand for the agricultural sector during the period of 32 years since the year 1975-2006 as a whole amounted to 140,864,017 tonnes, amounting to 91,471,685 tonnes of urea fertilizer with an average growth of 9.45% or 2,858,490 tonnes per year or 6.49% of the total, next is fertilizer AZ/AS (Zwalvelzure ammonia/Ammonium sulfate) of 13,884,818 tonnes, or a growth of 9.46% per year is equivalent to 433,901 tonnes per year or 0.99% of the total, while for fertilizer TSP/SP36 (Triple super phosphate/Super phosphate36) of 24,440,546 tonnes with an average growth of 9.95% or 763,767 tonnes per year or equal to 1.74% of the total, while for the development of KCl (Potassium chloride) fertilizer needs in this period amounted to 11,066,968 tonnes or average growth of 12.34% per annum or a total of 345,834 tonnes per year in other words contributed for 0.79% of the total. As shown in Table 2.18 and Fig. 2.4.

Fig 2.4.
Development needs of fertilizer for the agricultural sector in Indonesia (ton).

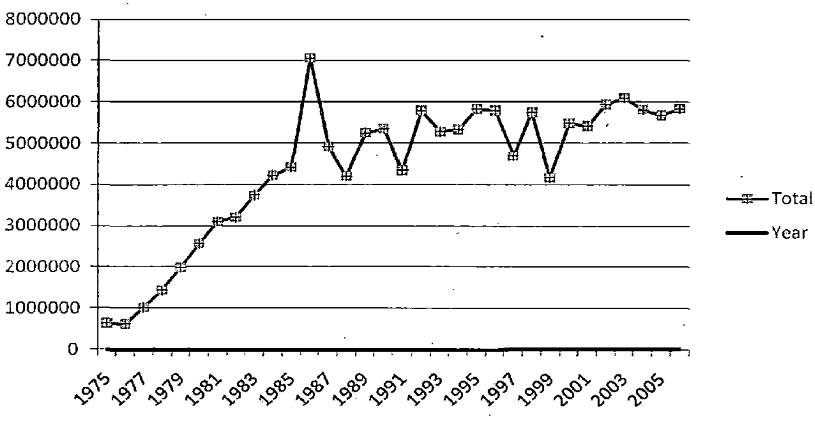


Table 2.18.
Development needs of fertilizer for the agricultural sector in Indonesia (ton), 1975-2006.

S.No.	Year	UREA	AS/ZA	TSP/SP36	KCl*	TOTAL
1.	1975	385,662	86,000	128,526	34,413	624,601
2.	1976	348,554	136,800	98,117	24,285	602,756
3.	1977	639,374	168,000	135,404	69,420	1,012,198
4.	1978	827,790	170,400	224,612	108,998	1,331,800
5.	1979	1,400,952	195,900	266,425	122,058	1,985,335
6.	1980	1,740,551	220,000	483,591	123,311	2,567,453
7.	1981	2,167,227	148,487	732,141	46,454	3,094,409
8.	1982	2,068,530	331,300	712,697	88,365	3,170,892
9.	1983	2,380,522	354,046	834,411	179,151	3,748,130
10.	1984	2,609,197	407,646	951,564	251,955	4,220,362
11.	1985	2,604,468	474,896	1,046,967	290,411	4,416,742
12.	1986	2,738,241	475,690	1,175,701	267,353	4,626,985
13.	1987	2,795,874	553,271	1,190,528	369,734	4,909,407
14.	1988	2,916,466	589,356	316,432	478,463	4,300,717
15.	1989	2,925,421	587,794	1,278,428	457,259	5,248,902
16.	1990	2,977,591	600,307	1,262,789	509,857	5,350,544
17.	1991	2,036,627	606,355	1,255,941	444,195	4,343,118
18.	1992	3,410,348	607,702	1,290,085	481,594	5,789,729
19.	1993	3,094,802	639,473	1,173,158	365,675	5,273,108
20.	1994	3,288,466	614,553	1,124,500	302,080	5,329,632
21.	1995	3,710,455	652,999	1,069,909	403,900	5,837,263
22.	1996	3,917,858	588,192	900,184	375,293	5,781,627
23.	1997	3,323,601	350,503	663,478	350,270	4,687,852
24.	1998	4,289,648	407,898	868,837	172,133	5,738,516
25.	1999	3,140,033	243,906	394,949	380,000	4,158,888
26.	2000	3,959,656	507,005	612,260	400,000	5,489,921
27.	2001	3,934,985	511,170	645,388	326,920	5,418,463
28.	2002	4,276,137	606,529	600,991	450,000	5,930,657
29.	2003	4,369,953	675,511	784,204	266,502	6,096,170
30.	2004	4,361,450	456,129	813,318	181,909	6,023,806
31.	2005	4,321,398	476,000	722,300	155,000	5,674,698
32.	2006	4,409,818	551,000	682,700	190,000	5,833,518

*) Potassium chloride
Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2007.

The development of export quantity of urea fertilizer during the period of 29 years in the period 1977-2005 amounted to 36,069,857 tonnes, or an average of 1,243,788 tonnes per year with an average growth of 15.73% per annum. PT Pusri with export capacity of 6,512,550 tonnes, or an average of 224,571 tonnes per year. PT Pupuk Kujang with export capacity of 2,006,474 tonnes, or an average of 69,189 tonnes per year with the percentage growth of 6.98%. PT Pupuk Kaltim Fertilizer with export capacity of 9,589,641 tonnes or an average of 330,677 tonnes per year with the percentage growth of 15.79% per annum. While PT AAF export capacity of 8,260,975 tonnes with an average of 284,861 tonnes per year or a growth of 6.40% per year. PT Pupuk Iskandar Muda with export capacity of 4,948,216 tonnes, or an average of 170,628 tonnes per year with the percentage growth of 12.16%. As for PT Petrokimia Gresik with export capacity of 4,752,001 tonnes or a total of 163,862 tonnes per year with the percentage growth of 13.09% per annum. As shown in Table 2.19.

Table 2.19.
Development exports of urea fertilizer in Indonesia (ton), 1977-2005.

S.No.	Year	PUSRI	KUJANG	KAL TIM	AAF	PIM	PETRO KIMIA	TOTAL
1.	1977	400,195	-	-	-	-	-	400,195
2.	1978	30,462	-	-	-	-	-	30,462
3.	1979	299,299	-	-	-	-	-	299,299
4.	1980	162,440	-	-	-	-	-	162,440
5.	1981	38,902	-	-	-	-	-	38,902
6.	1982	55,000	20,300	-	-	-	-	75,300
7.	1983	262,505	53,720	-	-	-	-	316,225
8.	1984	5,500	-	-	197,100	-	-	202,600
9.	1985	790,287	-	-	244,593	-	-	1,034,880
10.	1986	736,816	216,990	59,282	295,672	204,868	-	1,523,628
11.	1987	302,155	69,562	73,744	462,295	115,517	-	1,023,273
12.	1988	158,322	94,250	216,863	447,042	131,857	-	1,048,334
13.	1989	190,695	178,943	676,180	192,252	155,496	-	1,693,566
14.	1990	175,480	153,537	517,537	570,824	180,541	-	1,598,258
15.	1991	273,870	142,442	735,366	470,475	150,653	-	1,772,806
16.	1992	101,341	82,800	357,600	531,157	259,668	-	1,333,667
17.	1993	210,229	98,190	315,595	614,394	282,542	-	1,520,950
18.	1994	174,866	159,425	409,328	501,991	379,098	106,500	1,731,208
19.	1995	392,384	205,423	380,476	506,378	300,515	185,064	1,970,240
20.	1996	189,225	101,488	301,167	630,498	208,955	102,800	1,634,133
21.	1997	519,726	250,552	397,386	668,656	310,330	214,046	2,360,696
22.	1998	34,579	40,197	410,306	648,469	395,973	41,830	1,571,354
23.	1999	272,653	21,882	917,459	650,403	460,764	5,626	2,328,787
24.	2000	99,875	57,836	701,737	567,028	420,482	73,107	1,920,066
25.	2001	83,409	35,977	641,898	61,715	130,079	67,798	1,020,876
26.	2002	31,086	22,960	564,785	-	203,894	-	822,725
27.	2003	221,254	-	647,565	-	77,983	-	946,792
28.	2004	-	-	465,367	-	-	30	465,397
29.	2005	100,000	-	800,000	-	570,000	-	1,470,000

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2006.

Table 2.20.
Distribution of fertilizers for agricultural sector (ton), 2006.

S.No.	Provinces	Urea	SP36	ZA/AS	NPK	Total
1.	Nangro Aceh D	36,742	13,423	2,300	1,803	54,268
2.	Northern Sumatera	108,657	26,999	31,529	13,514	180,699
3.	Western Sumatera	42,856	23,550	13,300	8,019	87,725
4.	Jambi	27,470	5,638	1,513	1,379	36,000
5.	Riau	52,822	9,069	5,458	3,990	71,339
6.	Bengkulu	9,680	5,207	2,143	1,136	18,166
7.	Southern Sumatera	90,584	26,134	3,509	4,631	124,858
8.	Bangka Belitung	-	985	762	984	2,731
9.	Lampung	147,485	29,309	6,503	9,883	193,180
10.	DKI Jakarta	-	-	-	-	-
11.	Banten	49,640	12,670	3,173	4,355	69,838
12.	Western Java	550,833	100,252	47,560	35,415	734,060
13.	DI Yogyakarta	44,792	5,535	7,400	4,450	62,177
14.	Central Java	549,017	106,922	94,765	45,117	795,821
15.	Eastern Java	722,606	130,218	234,562	86,306	1,173,692
16.	Bali	40,701	4,625	8,124	7,155	60,605
17.	Western Kalimantan	21,505	5,773	242	4,098	31,618
18.	Cental Kalimantan	7,689	2,251	17	541	10,498
19.	Southern Kalimantan	23,378	6,425	948	2,752	33,503
20.	Eastern Kalimantan	8,724	4,240	874	1,640	15,478
21.	Northern Sulawesi	15,287	3,619	188	2,873	21,967
22.	Gorontalo	6,044	835	570	1,908	9,357
23.	Central Sulawesi	27,267	3,039	3,990	911	35,207
24.	Southeast Sulawesi	13,686	4,057	1,698	491	19,932
25.	Southern Sulawesi	158,508	23,054	28,969	7,189	217,720
26.	NTB	75,555	9,040	5,402	1,858	91,855
27.	NTT	13,733	4,487	67	255	18,542
28.	Maluku	1,204	18	22	41	1,285
29.	Papua	3,347	998	188	142	4,675
30.	Northern Maluku	629	176	-	88	893
31.	Western Irian Jaya	-	158	89	90	337
32.	Western Sulawesi	-	2.552	2,983	800	6335
33.	Riau Archipelago	-	-	-	-	-
Indonesia		**2,853,441**	**571,258**	**508,848**	**253,814**	**4,187,361**

Source : Directorate General of Horticulture, Ministry of Agriculture, Indonesia, 2007.

Distribution of fertilizer for the agricultural sector in 2006 as a whole amounted to 4,182,641 tonnes or a total of 126,747 tonnes for each province as a percentage of 19.64%, consisting of urea fertilizer at 2,850,441 tonnes or a total of 86,377 tonnes per province or equal to 20.31%, TSP/SP36 fertilizer (Triple Super Phosphate) of 571,258 tonnes per year or a total of 17,311 tonnes for each province, while the ZA/AS (Zwalvelzure ammonia/Ammonium sulphate) amounted to 507,848 tonnes or a total of 15,389 tonnes for each province, while fertilizer NPK amounted to 253,094 tonnes with an average of 7,670 tonnes or equivalent to 21.58% in each province, with the highest distribution in East Java province amounted to 1,173,692 tonnes or 2.81% of the total, followed by Central Java amounted to 795,821 tonnes or equal to 1.90% of the total, and West Java 734,060 tonnes or at 1.76% of the total. As shown in Table 2.20.

2.2.3. Type of Fertilizer

Fertilizers are very important to plants. Aside from sunlight and water, fertilizer is essential to them. If the soil is well-loamed and rich, it is a good source of nutrients for the plants in the area. However, if the soil has gone through cycles of planting and harvesting already, then it has been stripped of all the nutrients it can give. Since the soils can no longer meet the adequate needs of the plants, "supplements" in the form of fertilizers would have to be given to meet the nutritional needs of plants for optimum growth and yield. There are four types of fertilizers base on shape or form i.e. granular or powder, liquid, spikes and tabs. Each type is used specifically for a certain type of garden or plant or situation.

1. According to the shape/form.

Table 2.21. Type of fertilizer base on shape and form.

SNo.	Shape/form of Fertilizers	Description
1.	Granular or Powder	Also known as dry fertilizer, granular fertilizer is available in the form of dry pellets. It comes in different types depending on the materials used to make it, whether natural or synthetic. The basic fertilizer compounds of nitrogen, phosphorus and potassium are used to make synthetic granular fertilizer, while things like compost and manure are pelletized to make natural granular fertilizer. It is applied mostly prior to planting so that it releases the nutrients required for plant germination and growth. In some cases it can also be used in existing plants but it has to be watered to help it settle around the roots of the plants. Watering also keeps the plants from getting burnt. Its greatest advantage is that it releases nutrients in small bits over time, ensuring that the plants are not suffocated with nutrients. http://fertilizersupplier.com.my/services.htm

2.	Liquid	This liquid fertilizer usually comes in a concentrated liquid form. Application is normally done by attaching a hose and nozzle to a spray bottle. The concentrated fertilizer mixes with the water as it's applied. Basically if you can use a hose, you can apply liquid fertilizer with this easy method. Gone is lugging those back breaking 50 pound bags and spreading granular around the yard. However, liquid fertilizers are not long term, but the nutrients are available immediately to the roots and leaves. With liquid the results are immediate, applications need to be repeated more often than when applying granular. Liquid is more expensive to start with, and can be more costly. There are some liquid organic lawn fertilizer options, check the local garden center to see what they carry. http://www.plant-care.com/lawn-fertilizing.html
3.	Spikes	Fertilizer spikes specifically formulated for trees often contain both quick- and slow-release formulas, with some fertilizer tree spikes lasting for up to a year. Tree spikes are specially marked as such, and are often larger than their flower or lawn counterparts. Even more specialized tree spike products are available for fruit trees to encourage more bountiful and timely fruit harvest. Other specialized tree spike products include items for shade trees and evergreens. It should be noted that fertilizer spikes dissolve more rapidly in wet environments, and gardeners should plan their fertilization accordingly. http://www.wisegeek.com/what-are-fertilizer-spikes.htm
4.	Tabs	Formulated for moderate growth and strong blooming without algae growth. Fish safe and will not harm aquatic life. 1 tab for one gallon of soil, 2 tabs for 2 gallons of soil and so on. Fertilizes for 4-6 months.. http://www.ewaterlily.com/cgi-bin/shop/cart.pl?db=data.file&category=FERTILIZER+TABS

2. According to organic material.

Soil amendments are made by adding fertilizer to the soil but there are different types of fertilizers. There is bulky organic fertilizer such as cow manure, bat guano, bone meal, organic compost and green manure crops. And then there is also chemical fertilizer which is also referred to as inorganic fertilizer and is made up with different formulations to suit a variety of specified uses. Though many governments and agricultural departments go to great lengths to increase the supply of organic fertilizers, such as bulky organic manures and composting materials, there is just not enough of these fertilizers available to meet the existing and future fertilizer needs. Compared to organic compost, chemical or inorganic fertilizers also have the added advantage of being less bulky.

Being less bulky makes chemical fertilizer easier to transport, both overland and from the soil into the plants itself, because they get to be available to the plant relatively quickly when incorporated as part of the plant-food constituents. Chemical fertilizer usually comes in either granular or powder form in bags and boxes, or in liquid formulations in bottles. The different types of chemical fertilizers are usually classified according to the three principal elements, namely Nitrogen (N), Phosphorous (P) and Potassium (K), and may, therefore, be included in more than one group. Table below divide of fertilizer by two group, that are:

Table 2.22.
Type of fertilizer according to organic material.

S.No.	Material	Remark	Advantage	Disadvantages
1.	Organic	Organic Fertilizers are the most convenient forms of fertilizers. They are safe and easily available. Things like manure, slurry, worm castings, peat moss, seaweed, sewage and guano are good examples of organic fertilizers. Vegetation material called mulch, such as hay, peat moss, leaves, grass, bark, wood chips, seed hulls, and corn husks all help to aerate the soil, insulate the ground against temperature change, and add needed nutrients. Apart from these naturally occurring minerals like sulfate of potash, limestone and rock phosphate are also considered very good Organic Fertilizers.	•Improve the structure of the soil. •Retain soil moisture. •Release nitrogen slowly and consistently. •Mobilize existing soil nutrients. •Do not burn the plants like some chemical fertilizers •Less subject to leaching	•Often Organic fertilizers, especially those that contain animal and plant feces are contaminated with pathogens. Make sure they are properly composted to reduce the risk of pathogens. •The composition of organic fertilizers is variable thus it becomes a very dilute and inaccurate source of nutrients compared to Inorganic type of fertilizers. For profitable yields, significantly large amounts of fertilizers should be used to cope up with nutrient requirements.

2.	Inorganic or Chemical or systhetic	Inorganic or Chemical fertilizers are primarily derived from chemical compounds such as ammonium nitrate, ammonium phosphates and potassium chloride. sodium nitrate, mined rock phosphate and limestone are examples of Inorganic Fertilizers.	•Higher and accurate amount of nitrogen promotes protein and chlorophyl and encourages growth of stems and leaves. •Higher amount of phosphorus results more flowers, larger fruits, and healthier roots and tubers. •Potassium from potash fosters protein development and thickens stems and leaves. •Release of nitrogen rapid. •Accurate source of nutrients.	•Inorganic Fertilizers if used carelessly can burn your plants and distort the quality of your soil leading to cadmium poisoning. •Using Inorganic fertilizers would mean that strict watering schedules have to be adopted in order to retain the soil moisture. •Inorganic fertilizers are made up of elements like Potassium and phosphorus that come from mines or saline lakes thus from limited resources.

Source : http://gardening.ygoy.com/2007/07/24/types-of-fertilizers/

3. According to the type of spreader

There are only three basic types of fertilizer spreaders; the rotary or broadcast, the drop and the liquid or spray spreader. Table below divide of fertilizer by three groups, that are; Rotary/broadcast Fertilizer Spreaders, Drop Fertilizer Spreader, and Liquid/spray Fertilizer Spreader.

Table 2.23.
Type of fertilizer according on type of spreader

S.No.	Type of spreader	Description
1.	Rotary or Broadcast	The rotary spreader is used for spreading dry, evenly-sized fertilizers such as granular fertilizer. Rotary spreaders provide even coverage for soil and can also be used to reseed lawns and spread salt on winter ice. The rotary fertilizer spreader releases fertilizer onto a disk that throws in a semi-circle ahead of the machine. Sizes range from small, handheld spreaders (for smaller gardens) to larger push-along models (for larger yards). Handheld models are ideal for small areas and spaces near walkways and patios as they allow a greater degree of accuracy. The user must turn a hand

		crank at a steady rate to ensure even coverage. Push models are most effective when covering more open areas as they can lay fertilizer in an arc up to 3 feet around the hopper. You must walk at a steady pace when using this model to avoid applying fertilizer unevenly to different areas.
2.	Drop	The drop spreader can be used for granular fertilizer or uneven materials like mulch or compost. It requires open space for best results, as it must be worked in straight, overlapping lines. On each pass of a drop fertilizer spreader, you cover half of the previous pass. This is usually accomplished by matching up a marker with the wheel track of the previous pass. These fertilizers work by pushing fertilizer out through a gap in the bottom of the hopper to the ground directly below, hence the name "drop" spreader. The 2 most common sizes for drop fertilizer spreaders are push-along models and pull-along. Pull-along spreaders attach to riding mowers and sprinkle fertilizer as the grass is cut. This makes them an ideal choice for even application of mulch and grass clippings from a mower bag. Push models are effective in smaller areas where a riding mower is not able to make even passes.
3.	Liquid or Spray	Liquid fertilizer spreaders work by attaching a garden hose to a canister with an adapter nozzle. The canister contains dry fertilizer that is designed to dissolve quickly. The fertilizer is then sprayed out the end of the adapter nozzle. Liquid spreaders are good for quick, light fertilizing jobs, but lack the accuracy and even application provided by rotary or drop spreaders.

Source : http://www.doityourself.com/stry/3-types-of-fertilizer-spreaders

2.2.4. Application

Synthetic fertilizers are commonly used to treat fields used for growing maize, followed by barley, sorghum, rapeseed, soy and sunflower. One study has shown that application of nitrogen fertilizer on off-season cover crops can increase the biomass (and subsequent green manure value) of these crops, while having a beneficial effect on soil nitrogen levels for the main crop planted during the summer season. Fertilizer is important to the health and vigor of crops. The type of fertilizer selected by the owner, however, is a matter of choice. Many good fertilizers and choices are available at local hardware stores, garden centers, and builder supply stores.

A fertilizer reminded by definition, is any material or mixture used to supply one or more of the essential plant nutrient elements. Sixteen nutrients are essential for plant growth and development. Of the major nutrients, nitrogen, phosphorus, and potassium are required in relatively large amounts. Calcium, magnesium, and sulfur are also required in relatively large amounts, but are less likely to be deficient in the soil system. Micro-nutrients (such as iron, chlorine, manganese, boron, etc.) are essential to plants in relatively small amounts.

Nitrogen (N) is important because it promotes vigorous plant growth, increases top growth, and is a building block for protein. ***Phosphorus (P)*** promotes cell division and stimulates healthy root growth and is essential for seed germination. ***Potassium (K),*** also labeled as "potash", is an essential nutrient for photosynthesis which also promotes fruit formation and imparts disease resistance.

The purpose of fertilization is to provide nutrients (minerals) to the roots, blades. Some fertilizers, however, have important benefits for the soil system, especially if they contain organic matter which helps build soil life and better soil structure. All fertilizers are labeled with 3 numbers (i.e., 12-3-9 or 10-10-10), giving the percentage by weight of nitrogen (N), phosphate (P), and potash (K). These numbers are called the "guaranteed analysis". A complete fertilizer provides some quantity of all three of these nutrients. The amount of nitrogen needed is determined, in part, by the type of grass, soil health, site conditions, maintenance practices of the lawn owner, and goals of the owner.

The standard fertilizer application rate listed on the bag is one pound for every 1000 square feet for each application. The amount of fertilizer applied over the course of the year, not the total amount applied at each application time. The some specialist recommended 2 to 4 pounds of nitrogen per year, spread out over 2, 3, or 4 applications during the growing season. Despite the attention given to

N-P-K ratios in fertilizers, one of the most important recommendations for healthy care is to select a slow-release fertilizer. As described below, slow-release fertilizers provide for steady growth and water quality protection, a winning combination.

Organic vs. Synthetic Fertilizers

The choice of organic vs. synthetic (man-made) fertilizers is an individual one. There are excellent organic fertilizers and excellent synthetic fertilizers. The nutrients are the same after they are released into the soil system. An organic fertilizer, by definition, contains nutrients which are derived solely from the remains of (or are a by-product of) once living organisms. Examples of organic fertilizers include cottonseed meal, blood meal, composted manure, and bone meal. Urea is sometimes organic and sometimes synthetic in form. In general, organic fertilizers release their nutrients slowly over a fairly long time. (*Note*: synthetic fertilizer can also be made to release nutrients over a long period of time). Organic nutrients depend on microbial organisms in the soil to break down the material and make it available to plant roots.

On the other word, organic fertilizers may not have nutrients immediately available to plants at times of transplanting, and organic products may be more expensive than synthetic products. In general, a large quantity of organic fertilizer is needed to provide a given level of nutrients, at least when compared with formulated bags of synthetic fertilizers. A number of fertilizers formulated with a combination of organic and synthetic materials are available for purchase. These products attempt to combine the advantages of both types.

Soil Nutrient Testing – An Essential Step in Fertilizer Selection

Soil nutrient testing is important for healthy plants and clean water. A soil test is the best way to begin to learn about the nutrient needs. A soil test indicates nutrient levels already in the soil a first step in determining how much and what type of fertilizer is needed. Since plants take up nutrients from the soil, nutrients (contained in fertilizer) need to be replenished from time-to-time. Over-application of fertilizers can pollute water resources, ruin plants, and waste money. A recommendation for nitrogen is provided in the soil test results. The nitrogen component of the soil test recommendation reflects a computerized data base not the actual soil sample because nitrogen does not stay in the soil long enough to be effectively tested.

Fertilizer as a Source of Nitrogen and Phosphorus in Lakes, Streams, and Groundwater

The nutrient cycle in a managed is complex, consisting of many interacting inputs, outputs, and storage components. Atmospheric deposition, irrigation water, and grass clippings as well as fertilizer can be sources of nitrogen and phosphorus to the soil system. When quantities of phosphorus and nitrogen reach lakes, the growth of algae and aquatic weeds is stimulated. Nitrogen is particularly a concern for groundwater used for drinking, especially when found in concentrations above 10 parts per million. Phosphorus is an even greater concern for rivers, lakes, and ponds. In most lakes, for example, the amount of phosphorus determines the amount of algae and aquatic plants.

Many different land uses, including streets, lawns, and farmland, may be sources of nitrogen and phosphorus in small watersheds. The contributions from each small watershed vary, reflecting the natural characteristics of the site and types of uses. Recognizing that lawn fertilizers can easily be misapplied, over-fertilization is considered by many water quality experts to be a likely pollution source.

- Fertilizer may fall onto the sidewalk or driveway and be carried to storm drains or the river;
- Excessive fertilizer use on sloped lawns or "thin" lawn may lead to polluted runoff;
- Quick-release fertilizer applied before a heavy rainstorm may move through soil or runoff the surface of the ground.

Slow-Release Fertilizer for Steady Growth and Water Quality Protection

Slow-release fertilizers are recommended for all varieties, a slow-release fertilizer will promote steady, uniform growth and help protect water quality while providing the nitrogen (and other nutrients) necessary for healthy and growth.

Environmental Benefits from Slow-Release Fertilizers

The specialists recommended slow-release fertilizers for the following reasons:

a. To protect lakes, streams, and groundwater, reducing high-nitrogen runoff or leaching.
b. To promote steady, natural uniform grass growth, avoiding "spurts" of growth.
c. To provide essential nitrogen, a building block for protein in the grass blades and stems.
d. To reduce the danger of over-fertilization, including salt buildup or burning of crops.

e. To save time and money in the long run. Slow-release fertilizers typically. last more than 2-3 months. These products may appear to be more expensive, but actually be less expensive, since fewer applications are needed.

f. To protect soil microbial life and earthworms.

Slow-release fertilizers are often more expensive than quick-release products, but they last longer and fewer applications are needed. Slow-release fertilizers which are natural organic products (with organic matter) contribute to the general healthy of the soil. Healthy soil with diverse micro-organisms naturally resists pests and diseases.

Definition of Slow-Release Nitrogen Fertilizer

Slow release fertilizers include:

• Organic fertilizers (nitrogen released through microbial action); and

• Fertilizers with 50%[1] or more of their nitrogen in a water insoluble form.

Slowly-available nitrogen materials release a major portion of their nitrogen over relatively long periods of time. Two important reasons support this standard: (1) this type of slow-release fertilizer is available to landscape companies and to citizens; and (2) it protects water quality. Not all slow-release fertilizers have the low-phosphorus characteristics needed for a high level of water quality protection. Fertilizers which are both slow-release nitrogen and low-phosphorus are recommended.

Several Criteria for designation as an earth-friendly fertilizer:

1. Slow-release nitrogen: Natural organic fertilizer; or Synthetic fertilizer with 50% or more, or controlled-release component.

[1] The standard of 50% or more slowly available nitrogen is Recommended by Healthy Lawn and Garden Technical Advisory Committee for Oakland and Wayne Countries.

2. Low-phosphorus or no-phosphorus; Ratio of nitrogen-to-phosphate is 5:1 or greater.
3. Free of all pesticides (including herbicides); no weed-and-feed.

Determine Fertilizer Quantities

The application rate listed on the fertilizer bag is correct for most field: one pound of N for each 1000 square feet, for each application. It is the number of applications, not the amount of nitrogen per application that should be varied according to the type of field, condition of soil, maintenance practices, etc. The recommended 2, 3, or 4 fertilizer applications over the course of the growing season. This number of applications translates into a total of 2 pounds, 3 pounds, or 4 pounds of nitrogen per thousand square feet for the entire year. The owners are encouraged to "take charge" and determine the number of fertilizer applications (and the total amount of fertilizer) needed. The following guidelines are useful in making the determination:

1. If clippings are left on the lawn after mowing, fertilizer quantity can be reduced by 25% or more.
2. If in the partial shade, fertilizer applications can be reduced by 25% or more.
3. Different types of crops need different amounts of nitrogen to keep them healthy.
4. Soils with a "healthy" amount of organic matter (more than 5% by volume) may be able to reduce nitrogen fertilizer quantities. Organic matter contributes some nitrogen to the soil system as it decomposes.

If field are extremely concerned about the potential for fertilizer leaching or runoff, the fertilizer application rate can be reduced in half and the number of applications doubled. Finally, it should be remembered that it is fine to apply no fertilizer at all to the field. The only consequence of not applying fertilizer at all is the potential for crops a stressed that is prone to disease. Although the first year of a "no fertilizer" its may be fine, the second and third year may lead to an unsightly appearance which drives to apply herbicides and insecticides adding to environmental impacts rather than reducing them.

Timing of Fertilizer Applications

A little bit of nitrogen goes a long way to make crops green and healthy. When "too much" fertilizer is applied, grass grows fast and the potential for disease is increased. The fertilizer application selected by the homeowner should match the type of crops, the soil, and other personal choice factors. The "standard national" recommendations are not appropriate for all regions of the country or all field. For an easy-care, low-maintenance, a single application of slow-release fertilizer in the fall may be sufficient. For others who enjoy yard work and are looking for a thicker turf, two, three or four applications of fertilizer may be selected. In all cases, fertilizing during hot, dry weeks should be avoided. At such times the lawn requires water not fertility.

2.2.5. Fertilizers Problems

Many inorganic fertilizers may not replace trace mineral elements in the soil which become gradually depleted by crops. Use of fertilizers on a global scale emits significant quantities caused problems and impact as presented Table 2.24.

Table 2.24. Problems and impacts use of fertilizer

S.No.	Problems	Impacts
1.	Trace mineral depletion	Many inorganic fertilizers may not replace trace mineral elements in the soil which become gradually depleted by crops.
2.	Fertilizer burn	Over-fertilization of a vital nutrient can be as detrimental as underfertilization. "Fertilizer burn" can occur when too much fertilizer is applied, resulting in a drying out of the roots and damage or even death of the plant.
3.	High energy consumption	The production of synthetic ammonia currently consumes about 5% of global natural gas consumption, which is somewhat under 2% of world energy production. Natural gas is overwhelmingly used for the production of ammonia, but other energy sources, together with a hydrogen source, can be used for the production of nitrogen compounds suitable for fertilizers. The cost of natural gas makes up about 90% of the cost of producing ammonia. The increase in price of natural gases over the past decade, along with other factors such as increasing demand, have contributed to an increase in fertilizer price.
4	Long-Term Sustainability	Inorganic fertilizers are now produced in ways which theoretically cannot be continued indefinitely. Potassium and phosphorus come from mines (or saline lakes such as the Dead Sea) and such resources are limited. More effective fertilizer utilization practices may, however, decrease present usage from mines. Improved knowledge of crop production practices can potentially decrease fertilizer usage of P and K without reducing the critical need to improve and increase crop yields. Atmospheric (unfixed) nitrogen is effectively unlimited (forming over 70% of the atmospheric gases), but this is not in a form useful to plants. To make nitrogen accessible to plants requires nitrogen fixation (conversion of atmospheric nitrogen to a plant-accessible form. Artificial nitrogen fertilizers are typically synthesized using fossil fuels such as natural gas and coal, which are limited resources. In lieu of converting natural gas to syngas for use in the Haber process, it is also possible to convert renewable biomass to syngas (or wood gas) to supply the necessary energy for the process, though the amount of land and resources (ironically often including fertilizer) necessary for such a project may be prohibitive.
5.	Eutrophication	The nitrogen-rich compounds found in fertilizer run-off is the primary cause of a serious depletion of oxygen in many parts of the ocean, especially in coastal zones; the resulting lack of dissolved oxygen is greatly reducing the ability of these areas to sustain oceanic fauna. Visually, water may become cloudy and discolored (green, yellow, brown, or red). About half of all the lakes in the United States are now eutrophic, while the number of oceanic dead zones near inhabited coastlines are increasing. As of 2006, the application of nitrogen fertilizer is being increasingly controlled in Britain and the United States. If eutrophication can be reversed, it may take decades before the accumulated nitrates in groundwater can be broken down by natural processes.

		High application rates of inorganic nitrogen fertilizers in order to maximize crop yields, combined with the high solubilities of these fertilizers leads to increased runoff into surface water as well as leaching into groundwater. The use of ammonium nitrate in inorganic fertilizers is particularly damaging, as plants absorb ammonium ions preferentially over nitrate ions, while excess nitrate ions which are not absorbed dissolve (by rain or irrigation) into runoff or groundwater.
6.	Blue Baby Syndrome	Nitrate levels above 10 mg/L (10 ppm) in groundwater can cause 'blue baby syndrome' (acquired methemoglobinemia), leading to hypoxia (which can lead to coma and death if not treated).
7.	Soil acidification	Nitrogen-containing inorganic and organic fertilizers can cause soil acidification when added. This may lead to decreases in nutrient availability which may be offset by liming.
8.	Atmospheric effects	Global methane concentrations (surface and atmospheric) for 2005; note distinct plumes. Methane emissions from crop fields (notably rice paddy fields) are increased by the application of ammonium-based fertilizers; these emissions contribute greatly to global climate change as methane is a potent greenhouse gas. Through the increasing use of nitrogen fertilizer, which is added at a rate of 1 billion tons per year presently to the already existing amount of reactive nitrogen, nitrous oxide (N_2O) has become the third most important greenhouse gas after carbon dioxide and methane. It has a global warming potential 296 times larger than an equal mass of carbon dioxide and it also contributes to stratospheric ozone depletion. Storage and application of some nitrogen fertilizers in some weather or soil conditions can cause emissions of the potent greenhouse gas—nitrous oxide. Ammonia gas (NH_3) may be emitted following application of 'inorganic' fertilizers and/or manures and slurries. The use of fertilizers on a global scale emits significant quantities of greenhouse gas into the atmosphere. Emissions come about through the use of: animal manures and urea, which release methane, nitrous oxide, ammonia, and carbon dioxide in varying quantities depending on their form (solid or liquid) and management (collection, storage, spreading), fertilizers that use nitric acid or ammonium bicarbonate, the production and application of which results in emissions of nitrogen oxides, nitrous oxide, ammonia and carbon dioxide into the atmosphere. By changing processes and procedures, it is possible to mitigate some, but not all, of these effects on anthropogenic climate change.
9.	Increased pest health	Excessive nitrogen fertilizer applications can also lead to pest problems by increasing the birth rate, longevity and overall fitness of certain agricultural pests.

Source : http://en.wikipedia.org/wiki/Fertilizer

2.3. Drainage

Drainage is the natural or artificial removal of surface and sub-surface water from an area. Many agricultural soils need drainage to improve production or to manage water supplies. The earliest archaeological record of an advanced system of drainage comes from the Indus Valley Civilization from around 3,100 BC in what is now Pakistan and North India. The ancient Indus systems of sewerage and drainage that were developed and used in cities throughout the civilization were far more advanced than any found in contemporary urban sites in the Middle East and even more efficient than those in some areas of modern Pakistan and India today. Waste water was directed to covered drains, which lined the major streets.

From the 1881 Household, this operation is always best performed in spring or summer, when the ground is dry. Main drains ought to be made in every part of the field where a cross-cut or open drain was formerly wanted; they ought to be cut four feet (1.2 m) deep, upon an average. This completely secures them from the possibility of being damaged by the treading of horses or cattle, and being so far below the small drains, clears the water finely out of them. In every situation, pipe-turfs for the main drains, if they can be had, are preferable. If good stiff clay, a single row of pipe-turf; if sandy, a double row. When pipe-turf cannot be got conveniently, a good wedge drain may answer well, when the subsoil is a strong, stiff clay; but if the subsoil be only moderately so, a thorn drain, with couples below, will do still better; and if the subsoil is very sandy, except pipes can be had, it is in vain to attempt under-draining the field by any other method. It may be necessary to mention here that the size of the main drains ought to be regulated according to the length and declivity of the run, and the quantity of water to be carried off by them. It is always safe, however, to have the main drains large, and plenty of them; for economy here seldom turns out well.

Having finished the main drains, proceed next to make a small drain in every furrow of the field if the ridges formerly have not been less than fifteen feet (5 m) wide. But if that should be the case, first level the ridges, and make the drains in the best direction, and at such a distance from each other as may be thought necessary.

If the water rises well in the bottom of the drains, they ought to be cut three feet (1 m) deep, and in this ease would dry the field sufficiently well, although they were from twenty-five to thirty feet (8 to 10 m) asunder; but if the water does not draw well to the bottom of the drains, two feet (0.6 m) will be a sufficient deepness for the pipe-drain, and two and a half feet (1 m) for the wedge drain. In no case ought they to be shallower where the field has been previously leveled. In this instance, however, as the surface water is carried off chiefly by the water sinking immediately into the top of the drains, it will be necessary to have the drains much nearer each other--say from 15 - 20 feet (5 - 6 m).

If the ridges are more than fifteen feet (5 m) wide, however broad and irregular they may be, follow invariably the line of the old furrows, as the best direction for the drains; and, where they are high-gathered ridges, from twenty to twenty-four inches will be a sufficient depth for the pipe-drain, and from twenty-four to thirty inches for the wedge-drain. Particular care should be taken in connecting the small and main drains together, so that the water may have a gentle declivity, with free access into the main drains.

When the drains are finished, the ridges are cleaved down upon the drains by the plough; and where they had been very high formerly, a second clearing may be given; but it is better not to level the ridges too much, for by allowing them to retain a little of their former shape, the ground being lowest immediately where the drains are, the surface water collects upon the top of the drains, and by shrinking into them, gets freely away. After the field is thus finished, run the new ridges across the small drains, making them about ten feet (3 m) broad, and continue afterwards to plough the field in the same manner as dry land.

It is evident from the above method of draining that the expense will vary very much, according to the quantity of main drains necessary for the field, the distance of the small drains from each other, and the distance the turf is to be carried. The advantage resulting from under-draining, is very great, for besides a considerable saving annually of water furrowing, cross cutting, etc., the land can often be ploughed and sown to advantage, both in the spring and in the fall of the year, when otherwise it would be found quite impracticable; every species of drilled crops, such as beans, potatoes, turnips, etc., can be cultivated successfully, and every species, both of green and white crops, is less apt to fail in wet and untoward seasons.

Wherever a burst of water appears in any particular spot, the sure and certain way of getting quit of such an evil is to dig hollow drains to such a depth below the surface as is required by the fall or level that can be gained, and by the quantity of water expected to proceed from the burst. Having ascertained the extent of water to be carried off, taken the necessary levels, and cleared a mouth or loading passage for the water, begin the drain at the extremity next to that leader, and go on with the work till the top of the spring is touched, which probably will accomplish the intended object. But if it should not be completely accomplished, run off from the main drain with such a number of branches as may be required to intercept the water, and in this way disappointment will hardly be experienced. Drains, to be substantially useful, should seldom be less than three feet (1 m) in depth, twenty or twenty four inches thereof to be close packed with stones or wood, according to circumstances. The former are the best materials, but in many places are not to be got in sufficient quantities; recourse therefore, must often be made to the latter, though not so effectual or durable.

It is of vast importance to fill up drains as fast as they are dug out; because, if left open for any length of time, the earth is not only apt to fall in but the sides get into a broken, irregular state, which cannot afterwards be completely rectified. A proper covering of straw or sod should be put upon the top of the materials, to keep the surface earth from mixing with them; and where wood is the material used for filling up, a double degree of attention is necessary, otherwise the proposed improvement may be effectually frustrated. The pit method of draining is a very effectual one, if executed with judgment. When it is sufficiently ascertained where the bed of water is deposited, which can easily be done by boring with an auger, sink a pit into the place of a size which will allow a man freely to work within its bounds.

Dig this pit of such a depth as to reach the bed of the water meant to be carried off and when this depth is attained, which is easily discerned by the rising of the water, fill up the pit with great land-stones and carry off the water by a stout drain to some adjoining ditch or mouth, whence it may proceed to the nearest river.

Drainage in construction

The civil engineer or site engineer is responsible for drainage in construction projects. They set out from the plans all the roads, Street gutters, drainage, culverts and sewers involved in construction operations. During the construction of the work on site will set out all the necessary levels for each of the previously mentioned factors. Site engineers work alongside architects and construction managers, supervisors, planners, quantity surveyors, the general workforce, as well as subcontractors. Typically, most jurisdictions have some body of drainage law to govern to what degree a land owner can alter the drainage from his parcel.

Reasons for artificial drainage

An agricultural drainage channel outside Magome, Japan after a heavy rain, note that protuberances create turbulent water, preventing sediment from settling in the channel. Wetland soils may need drainage to be used for agriculture. Some of these were drained using open ditches and trenches to make mucklands, which are primarily used for high value crops such as vegetables.

The largest project of this type in the world has been in process for centuries in the Netherlands. The area between Amsterdam, Haarlem and Leiden was, in prehistoric times swampland and small lakes. Turf cutting (Peat mining), subsidence and shoreline erosion gradually caused the formation of one large lake. The invention of wind powered pumping engines in the 15th century permitted drainage of some of the marginal land, but the final drainage of the lake had to await the design of large, steam powered pumps and agreements between regional authorities. The elimination of the lake occurred between 1849 and 1852, creating thousands of square km of new land.

Coastal plains and river deltas may have seasonally or permanently high water tables and must have drainage improvements if they are to be used for agriculture. After periods of high rainfall, drainage pumps are employed to prevent damage to the citrus groves from overly wet soils. Rice production requires complete control of water, as fields need to be flooded or drained at different stages of the crop cycle. The Netherlands has also led the way in this type of drainage, not only to drain lowland along the shore, but actually pushing back the sea until the original nation has been greatly enlarged.

In moist climates, soils may be adequate for cropping with the exception that they become waterlogged for brief periods each year, from snow melt or from heavy rains. Soils that are predominantly clay will pass water very slowly downward, meanwhile plant roots suffocate because the excessive water around the roots eliminates air movement through the soil.

Other soils may have an impervious layer of mineralized soil, called a hardpan or relatively impervious rock layers may underlie shallow soils. Drainage is especially important in tree fruit production. Soils that are otherwise excellent may be waterlogged for a week of the year, which is sufficient to kill fruit trees and cost the productivity of the land until replacements can be established. In each of these cases appropriate drainage carries off temporary flushes of water to prevent damage to annual or perennial crops.

Drier areas are often farmed by irrigation, and one would not consider drainage necessary. However, irrigation water always contains minerals and salts, which can be concentrated to toxic levels by evapotranspiration. Irrigated land may need periodic flushes with excessive irrigation water and drainage to control soil salinity.

Drainage system

The drainage system may refer to:

- A drainage system (geomorphology), the pattern formed by the streams, rivers, and lakes in a particular drainage basin.
- A drainage system (agriculture), an intervention to control waterlogging aiming at soil improvement for agricultural production.
- A drainage system in urban and industrial areas, a facility to dispose of liquid waste.

Sustainable urban drainage systems

Sustainable Drainage Systems (SuDS), sometimes known as Sustainable Urban Drainage Systems (SUDS), are designed to reduce the potential impact of new and existing developments with respect to surface water drainage discharges.

The idea behind SUDS is to try to replicate natural systems that use cost effective solutions with low environmental impact to drain away dirty and surface water run-off through collection, storage, and cleaning before allowing it to be released slowly back into the environment, such as into water courses. This is to counter the effects of conventional drainage systems that often allow for flooding, pollution of the environment -with the resultant harm to wildlife and contamination of groundwater sources used to provide drinking water. The paradigm of SUDS solutions should be that of a system that is easy to manage, requiring little or no energy input (except from environmental sources such as sunlight, etc.), resilient to use, and being environmentally as well as aesthetically attractive. Examples of this type of system are reed beds and other wetland habitats that collect, store, and filter dirty water along with providing a habitat for wildlife.

Originally the term SUDS described the UK approach to sustainable urban drainage systems. These developments may not necessarily be in "urban" areas, and thus the "urban" part of SUDS is now usually dropped to reduce confusion. Other countries have similar approaches in place using a different terminology such as Best Management Practice (BMP) and Low Impact Development in the United States.

2.4. Water Resources

Water resources are sources of water that are useful or potentially useful to humans. Uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually all of these human uses require fresh water. About 97% of water on the Earth is salt water, and only 3% is fresh water of which slightly over two thirds is frozen in glaciers and polar ice caps.The remaining unfrozen freshwater is mainly found as groundwater, with only a small fraction present above ground or in the air[2].

Fresh water is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. Water demand already exceeds supply in many parts of the world and as the world population continues to rise, so too does the water demand. Awareness of the global importance of preserving water for ecosystem services has only recently emerged as, during the 20th century, more than half the

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[2] "Scientific Facts on Water: State of the Resource". GreenFacts Website. http://www.greenfacts.org/en/water-resources/index.htm#2. Retrieved 2008-01-31.

world's wetlands have been lost along with their valuable environmental services. Biodiversity-rich freshwater ecosystems are currently declining faster than marine or land ecosystems[3]. The framework for allocating water resources to water users (where such a framework exists) is known as water rights.

2.4.1. Sources of Fresh Water

2.4.1.1. Surface water

Surface water is water in a river, lake or fresh water wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, and sub-surface seepage.

Although the only natural input to any surface water system is precipitation within its watershed, the total quantity of water in that system at any given time is also dependent on many other factors. These factors include storage capacity in lakes, wetlands and artificial reservoirs, the permeability of the soil beneath these storage bodies, the runoff characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All of these factors also affect the proportions of water lost.

Human activities can have a large and sometimes devastating impact on these factors. Humans often increase storage capacity by constructing reservoirs and decrease it by draining wetlands. Humans often increase runoff quantities and velocities by paving areas and channelizing stream flow.

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[3] Hoekstra, A.Y. 2006. The Global Dimension of Water Governance: Nine Reasons for Global Arrangements in Order to Cope with Local Problems. *Value of Water Research Report Series* No. 20 UNESCO-IHE Institute for Water Education.

The total quantity of water available at any given time is an important consideration. Some human water users have an intermittent need for water. For example, many farms require large quantities of water in the spring, and no water at all in the winter. To supply such a farm with water, a surface water system may require a large storage capacity to collect water throughout the year and release it in a short period of time. Other users have a continuous need for water, such as a power plant that requires water for cooling. To supply such a power plant with water, a surface water system only needs enough storage capacity to fill in when average stream flow is below the power plant's need.

Nevertheless, over the long term the average rate of precipitation within a watershed is the upper bound for average consumption of natural surface water from that watershed. Natural surface water can be augmented by importing surface water from another watershed through a canal or pipeline. It can also be artificially augmented from any of the other sources listed here, however in practice the quantities are negligible. Humans can also cause surface water to be lost (i.e. become unusable) through pollution.

2.4.1.2. Under river flow

Throughout the course of the river, the total volume of water transported downstream will often be a combination of the visible free water flow together with a substantial contribution flowing through sub-surface rocks and gravels that underlie the river and its flood plain called the hyporheic zone. For many rivers in large valleys, this unseen component of flow may greatly exceed the visible flow. The hyporheic zone often forms a dynamic interface between surface water and true ground-water receiving water from the ground water when aquifers are fully charged and contributing water to ground-water when ground waters are depleted.

2.4.1.3. Ground water

Sub-surface water or groundwater is fresh water located in the pore space of soil and rocks. It is also water that is flowing within aquifers below the water table. Sometimes it is useful to make a distinction between sub-surface water that is closely associated with surface water and deep sub-surface water in an aquifer (sometimes called "fossil water").

Sub-surface water can be thought of in the same terms as surface water: inputs, outputs and storage. The critical difference is that due to its slow rate of turnover, sub-surface water storage is generally much larger compared to inputs than it is for surface water. This difference makes it easy for humans to use sub-surface water unsustainably for a long time without severe consequences. Nevertheless, over the long term the average rate of seepage above a sub-surface water source is the upper bound for average consumption of water from that source. The natural input to sub-surface water is seepage from surface water. The natural outputs from sub-surface water are springs and seepage to the oceans.

If the surface water source is also subject to substantial evaporation, a sub-surface water source may become saline. This situation can occur naturally under endorheic bodies of water, or artificially under irrigated farmland. In coastal areas, human use of a sub-surface water source may cause the direction of seepage to ocean to reverse which can also cause soil salinization. Humans can also cause sub-surface water to be "lost" (i.e. become unusable) through pollution. Humans can increase the input to a sub-surface water source by building reservoirs or detention ponds.

2.4.1.4. Desalination

Desalination is an artificial process by which saline water (generally sea water) is converted to fresh water. The most common desalination processes are distillation and reverse osmosis. Desalination is currently expensive compared to most alternative sources of water, and only a very small fraction of total human use is satisfied by desalination. It is only economically practical for high-valued uses (such as household and industrial uses) in arid areas.

2.4.1.5. Frozen water

Several schemes have been proposed to make use of icebergs as a water source, however to date this has only been done for novelty purposes. Glacier runoff is considered to be surface water. The Himalayas, which are often called "The Roof of the World", contain some of the most extensive and rough high altitude areas on Earth as well as the greatest area of glaciers and permafrost outside of the poles. Ten of Asia's largest rivers flow from there, and more than a billion people's livelihoods depend on them. To complicate matters, temperatures are rising more rapidly here than the global average.

2.4.2. Uses of fresh water

Uses of fresh water can be categorized as consumptive and non-consumptive (sometimes called "renewable"). A use of water is consumptive if that water is not immediately available for another use. Losses to sub-surface seepage and evaporation are considered consumptive, as is water incorporated into a product (such as farm produce). Water that can be treated and returned as surface water, such as sewage, is generally considered non-consumptive if that water can be put to additional use.

2.4.2.1. Agricultural

It is estimated that 69% of worldwide water use is for irrigation, with 15-35% of irrigation withdrawals being unsustainable[4]. In some areas of the world irrigation is necessary to grow any crop at all, in other areas it permits more profitable crops to be grown or enhances crop yield. Various irrigation methods involve different trade-offs between crop yield, water consumption and capital cost of equipment and structures. Irrigation methods such as furrow and overhead sprinkler irrigation are usually less expensive but are also typically less efficient, because much of the water evaporates, runs off or drains below the root zone.

Other irrigation methods considered to be more efficient include drip or trickle irrigation, surge irrigation, and some types of sprinkler systems where the sprinklers are operated near ground level. These types of systems, while more expensive, usually offer greater potential to minimize runoff, drainage and evaporation. Any system that is improperly managed can be wasteful, all methods have the potential for high efficiencies under suitable conditions, appropriate irrigation timing and management. One issue that is often insufficiently considered is salinization of sub-surface water.

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[4] "WBCSD Water Facts & Trends". http://www.wbcsd.org/includes/getTarget.asp?type=d&id=MTYyNTA. Retrieved 2009-03-12.

Aquaculture is a small but growing agricultural use of water. Freshwater commercial fisheries may also be considered as agricultural uses of water, but have generally been assigned a lower priority than irrigation. As global populations grow, and as demand for food increases in a world with a fixed water supply, there are efforts underway to learn how to produce more food with less water, through improvements in irrigation[5]. methods[6] and technologies, agricultural water management, crop types, and water monitoring.

2.4.2.2. Industrial

It is estimated that 22% of worldwide water use is industrial[7]. Major industrial users include power plants, which use water for cooling or as a power source (i.e. hydroelectric plants), ore and oil refineries, which use water in chemical processes, and manufacturing plants, which use water as a solvent.

The portion of industrial water usage that is consumptive varies widely, but as a whole is lower than agricultural use. Water is used in power generation. Hydroelectricity is electricity obtained from hydropower. Hydroelectric power comes from water driving a water turbine connected to a generator. Hydroelectricity is a low-cost, non-polluting, renewable energy source. The energy is supplied by the sun. Heat from the sun evaporates water, which condenses as rain in higher altitudes, from where it flows down. Pressurized water

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[5] "Water Development and Management Unit - Topics - Irrigation". FAO. http://www.fao.org/nr/water/topics_irrigation.html. Retrieved 2009-03-12.

[6] "FAO Water Unit | Water News: water scarcity". Fao.org. http://www.fao.org/nr/water/news/masscote.html. Retrieved 2009-03-12.

[7] "WBCSD Water Facts & Trends". http://www.wbcsd.org/includes/getTarget.asp?type=d&id=MTYyNTA. Retrieved 2009-03-12.

is used in water blasting and water jet cutters. Also, very high pressure water guns are used for precise cutting. It works very well, is relatively safe, and is not harmful to the environment. It is also used in the cooling of machinery to prevent over-heating, or prevent saw blades from over-heating.

Water is also used in many industrial processes and machines, such as the steam turbine and heat exchanger, in addition to its use as a chemical solvent. Discharge of untreated water from industrial uses is pollution. Pollution includes discharged solutes (chemical pollution) and discharged coolant water (thermal pollution). Industry requires pure water for many applications and utilizes a variety of purification techniques both in water supply and discharge.

2.4.2.3. Household

It is estimated that 8% of worldwide water use is for household purposes[8]. These include drinking water, bathing, cooking, sanitation, and gardening. Basic household water requirements have been estimated by Peter Gleick at around 50 liters per person per day, excluding water for gardens. Drinking water is water that is of sufficiently high quality so that it can be consumed or used without risk of immediate or long term harm. Such water is commonly called potable water. In most developed countries, the water supplied to households, commerce and industry is all of drinking water standard even though only a very small proportion is actually consumed or used in food preparation.

2.4.2.4. Recreation

[8] "WBCSD Water Facts & Trends". http://www.wbcsd.org/includes/getTarget.asp?type=d&id=MTYyNTA. Retrieved 2009-03-12.

Recreational water use is usually a very small but growing percentage of total water use. Recreational water use is mostly tied to reservoirs. If a reservoir is kept fuller than it would otherwise be for recreation, then the water retained could be categorized as recreational usage. Release of water from a few reservoirs is also timed to enhance whitewater boating, which also could be considered a recreational usage. Other examples are anglers, water skiers, nature enthusiasts and swimmers.

Recreational usage may reduce the availability of water for other users at specific times and places. For example, water retained in a reservoir to allow boating in the late summer is not available to farmers during the spring planting season. Water released for whitewater rafting may not be available for hydroelectric generation during the time of peak electrical demand.

2.4.2.5. Environmental

Explicit environmental water use is also a very small but growing percentage of total water use. Environmental water usage includes artificial wetlands, artificial lakes intended to create wildlife habitat, fish ladders, and water releases from reservoirs timed to help fish spawn.

Like recreational usage, environmental usage is non-consumptive but may reduce the availability of water for other users at specific times and places. For example, water release from a reservoir to help fish spawn may not be available to farms upstream.

CHAPTER III

Description of the Study Area

CHAPTER III

DESCRIPTION OF THE STUDY AREA

3.1. General

The province of Bangka Belitung (BABEL) Islands is the 31st Province in Indonesia, one of the newest provinces formed on November 21st, 2000. Supported by the "*Serumpun Sebalai*" spirit and abundant natural resources, it has been expecting a greater role to speed up the island region's development, namely Bangka regency, Belitung regency and Pangkalpinang city through cooperation development. The geography location was quite advantageous for various economic sector developments, due to its strategic position within the economic growth triangle: Singapore-Johor-Riau and Batam region as well as Natuna Island. Considering its archipelago characteristics, the sea transportation has been the focus of development.

It is true that the sea transportation infrastructure is a requisite to support its economic activities, particularly accessibility among the islands. Besides, the government dedicatedly provides the accomplishment of other economic infrastructures such as building quays, developing new sea routes and cargo shipping availability.

3.2. Geographical Boundaries

The province of Bangka Belitung is located between 104°50' - 109°30' East Longitude and 0°50' - 4°10' South Latitude, with its total area of 81,724.54 sq.km. The administrative system comprises of two regencies and one city, namely Bangka regency, Belitung regency and Pangkalpinang City, of which, the biggest regency's area is Bangka regencies with 11,343.14 square km area, Belitung regencies with 3,509.79 square km and the smallest is Pangkalpinang City, with 118.31 square km area, detail as shown in Table 3.1.

Fig. 3.1. Location of Bangka Belitung Province.

The province is surrounded by South China Sea, Bangka straights and Java Sea. Bangka lies just east of Sumatera, separated by Bangka Strait. The marine environment around these islands is colorful. Bangka Island, which is situated at the Southern of the China Sea, it's between Sumatera and Borneo Island. The land area is about 11,5 thousands square km, stretching 180 km from Northwest to Southeast, the island has various highlands that are mostly located in the middle of the island and many rivers follow diverse of the open sea.

Table 3.1. Area of Bangka Belitung Province

S.No.	Regencies/City/District		Area (sq.km)
1.	**Pangkalpinang City**		**118.31**
	1.	Rangkui District	7.78
	2.	Bukit Intan District	36.54
	3.	Pangkal Balam District	35.56
	4.	Taman Sari District	1.33
	5.	Gerunggang District	37.10
2.	**Bangka Regency**		**2,849.68**
	1.	Sungai Liat District	145.49
	2.	Bakam District	410.96
	3.	Pemali District	145.78
	4.	Merawang District	256.82
	5.	Puding Besar District	393.42
	6.	Mendo Barat District	522.63
	7.	Belinyu District	445.55
	8.	Riau Silip District	529.03
3.	**Western Bangka Regency**		**2,820.61**
	1.	Muntok District	329.08
	2.	Simpang Teritip District	769.59
	3.	Kelapa District	617.78
	4.	Tempilang District	440.87
	5.	Jebus District	663.29
4.	**Central Bangka Regency**		**2,155.77**
	1.	Koba District	937.66
	2.	Pangkalan Baru District	285.97
	3.	Sungai Selan District	663.76
	4.	Simpang Katis District	268.38
5.	**Southern Bangka Regency**		**3,517.08**
	1.	Payung District	760.63
	2.	Simpang Rimba District	486.11
	3.	Toboali District	545.90
	4.	Tukak Sadai District	211.48
	5.	Pulau Besar District	315.24
	6.	Air Gegas District	948.41
	7.	Lepar Pongok District	249.31
Total Area of Bangka Island			**11,461.45**

S.No.	Regencies/City/District	Area (sq.km)
1.	**Belitung Regency**	**1,352.47**
	1. Membalong District	145.49
	2. Tanjung Pandan District	410.96
	3. Badau District	145.78
	4. Sijuk District	256.82
	5. Selat Nasik District	393.42
2.	**Estern Belitung Regency**	**2,157.32**
	1. Manggar District	329.08
	2. Gantung District	769.59
	3. Dendang District	617.78
	4. Kelapa Kampit District	440.87
Total Area of Belitung Island		**3,509.79**
Total Area of Bangka Belitung Islands		**14,971.24**

Source : http://www.babel.bps.go.id/

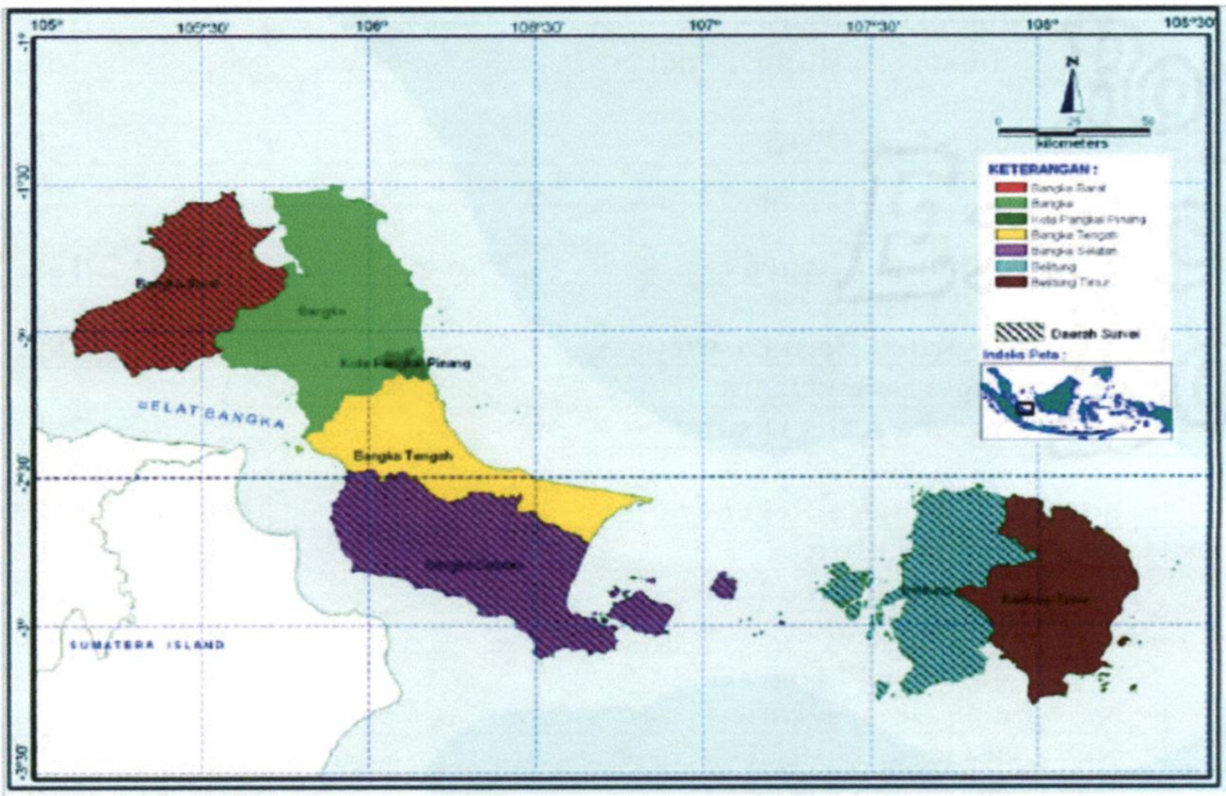


Fig. 3.2. Administrative Map of Bangka Belitung Province.

There are many beautiful beaches located in the Northwest of Bangka Island. This Island is bordered by:

Northern side : Natuna Sea

Eastern side : Natuna Sea

Southern side : Pangkalpinang city and Central Bangka Regency

Western side : Western Bangka Regency, Bangka Strait and Kelabat Bay.

3.3. Drainage Basin/Catchment Area

Catchment area or drainage basin, area drained by a stream or other body of water. The limits of a given catchment area are the heights of land-often called drainage divides, or watersheds-separating it from neighboring drainage systems. The amount of water reaching the river, reservoir, or lake from its catchment area depends on the size of the area, the amount of precipitation, and the loss through evaporation (determined by temperature, winds, and other factors and varying with the season) and through absorption by the earth or by vegetation, absorption is greater when the soil or rock is permeable than when it is impermeable. A permeable layer over an impermeable layer may act as a natural reservoir, supplying the river or lake in very dry seasons.

Water system in the river of Baturusa Cerucuk divided into two groups based on geographical location, namely in the area is Baturusa river zone in Bangka Island with the water system divided into 17 Rivers Basin, while the Cerucuk river zone in Belitung Island divided into 13 Rivers Basin include catchment area and discharge that is as shown in Table 3.2. and Figure 3.3. (Detail as presented in Appendix 3).

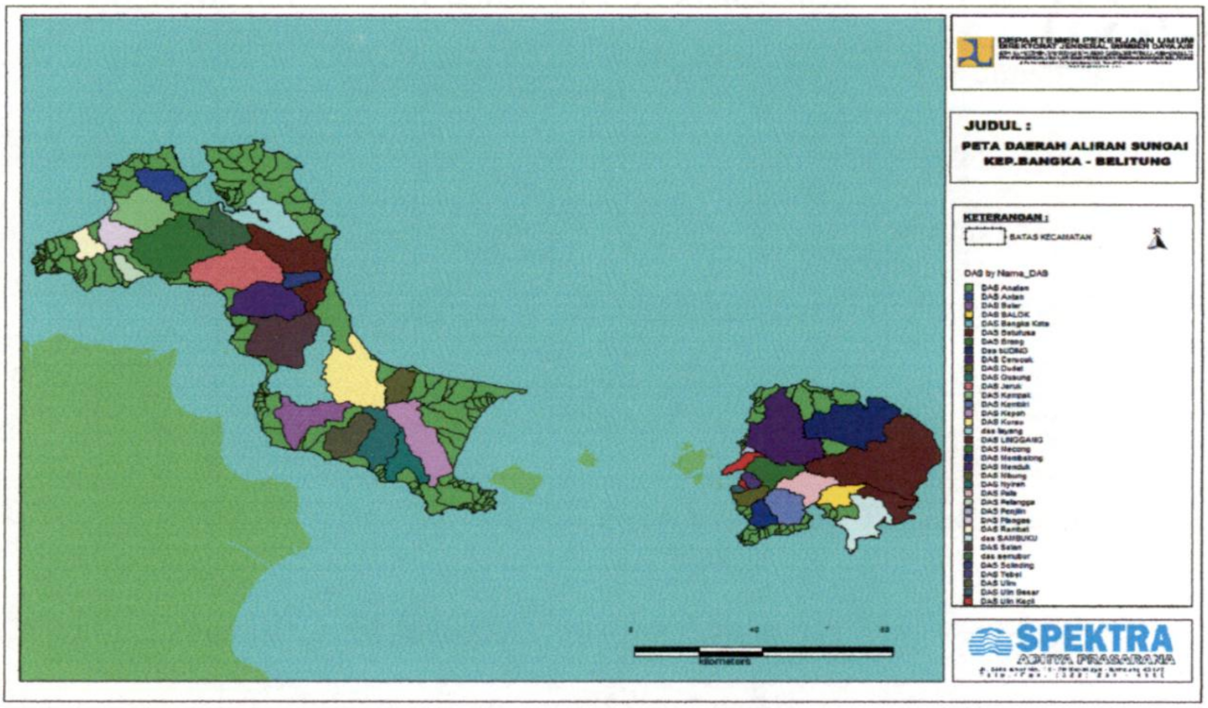


Fig. 3.3. Catchment Area/River Basins Map of Bangka Belitung Province.

Table 3.2.
Name of Rivers, Catchment Area and Discharge in the
Baturusa Cerucuk River Zone

Baturusa River Zone (Bangka Island)					
S.No.	**Name of River**	**Catchment Area**	**%**	**Discharge**	
		(sq. km)		**(m^3/year)**	**(Cumec)**
1.	Baturusa river	648,844	9.67	300,557,525.28	9.531
2.	Mecong river	624,127	9.30	289,108,116.25	9.168
3.	Kurau river	570,321	8.50	264,184,100.30	8.377
4.	Jeruk river	535,324	7.98	247,972,789.55	7.863
5.	Selan river	527,550	7.86	244,371,717.18	7.749
6.	Bangka Kota river	521,934	7.78	241,770,273.60	7.666
7.	Kepoh river	454,804	6.78	210,674,314.21	6.680
8.	Menduk river	387,284	5.77	179,397,699.02	5.689
9.	Layang river	359,584	5.36	166,566,504.69	5.282
10.	Kampak river	357,642	5.33	165,666,931.43	5.253
11.	Balar river	348,492	5.19	161,428,468.32	5.119
12.	Nyireh river	299,243	4.46	138,615,345.97	4.395
13.	Semubur river	282,220	4.21	130,729,951.71	4.415
14.	Ulim river	255,945	3.82	118,558,845.90	3.759
15.	Antan river	194,722	2.90	90,499,127.12	2.860
16.	Gusung river	191,381	2.85	88,651,509.06	2.811
17.	Nibung river	148,814	2.22	68,933,622.82	2.186
Total		**6,708.231**	**100.00**	**3,107,386,842.43**	**98.535**

Cerucuk River Zone (Belitung Island)					
S.No.	Name of River	Catchment Area	%	Discharge	
		(sq. km)		(m^3/year)	(Cumec)
1.	'Membalong river	102.966	3.57	139,293,522.98	4.417
2.	Dudat river	76.687	2.66	103,743,006.40	3.290
3.	Tebel river	38.691	1.34	52,341,604.97	1.660
4.	Brang river	183.289	6.36	247,955,349.67	7,863
5.	Cerucuk river	551.388	1.14	745,923,674.33	23.653
6.	Kubu river	42.881	1.49	58,009,882.48	1.839
7.	Padang river	72.152	2.50	97,608,009.15	3.095
8.	Buding river	482.615	16.75	652,883,813.07	20.703
9.	Manggar river	282.624	9.81	382,336,816.42	12.124
10.	Semulu river	188.273	6.54	254,697,759.00	8.076
11.	Senusur river	40.279	1.40	54,489,868.62	1.728
12.	Linggang river	697.275	24.21	943,281,192.23	29.911
13.	Balok river	121.552	4.22	164,436,865.62	5.214
Total		**2,880.672**	**100.00**	**3,897,004,364.95**	**123.573**

Source : Departement of Public Work, Directorate General of Water Resources, Regional of Sumatera VIII, 2007.

3.4. Drainage System

Drains and their flows are specialized drainage systems which are designed to handle an excess of water as a result of flooding or heavy rainfall. They are frequently found in major cities, especially in flood prone areas. A number of systems are used for the collection and ultimate discharge of water from storm drains, and if there are storm drains in your area, it may be interesting for you to learn about how the water is processed before it is discharged.

When rainfall is heavy, the streets, parking lots, and other flat areas of a town can flood. In addition to the water falling directly on these surfaces, gutters also discharge large amounts of water into the street. The flooding can pose a hazard, that is why storm drains are installed. The storm drains are frequently located on either side of a street, at a low point in the roadway where water would naturally collect. Typically, a large grate covers the storm drain, which takes the form of a giant pipe.

The storm drains are known as storm water drains or a surface water system. Water flows down the pipes and meets up with other pipes, creating an ever larger central pipe. In many areas, the storm drain system is kept entirely separate from the sewer system. When water from the storm drains flows into a body of water, it can potentially disturb flooding to locations downstream, in the case of a river. It also poses a major pollution risk, because spills in the streets will be carried through the unfiltered storm drain system.

3.5. Stream Flows

Streamflow, or channel runoff, is the flow of water in streams, rivers, and other channels, and is a major element of the water cycle. It is one component of the runoff of water from the land to waterbodies, the other component being surface runoff. Water flowing in channels comes from surface runoff from adjacent hillslopes, from groundwater flow out of the ground, and from water discharged from pipes. Runoff of water in channels is responsible for transport of sediment, nutrients, and pollution downstream.

3.6. Soil Condition

The soils distributed in the Bangka Island are fine textured (clay to silty clay) and their pH is generally below 5. Among them, Alluvial, Hedromorf, Podzolik and Litosol are categorized as highly fragile to surface soil erosion.

The parent material from which the soil is being derived is also of great importance, for if the land surface is relatively recent, or if for any reason unweathered rock particle are in the root zone of the vegetation, appreciable amounts of mineral nutrients will be released by the weathering ot these particles with a consequent effect on the luxuriance of crops being grown on the land, and this effect again is much more noticable in the tropics because of the much greater intensity of weathering. On the other hand, if the soil is formed on a crust of weathering on an old land surface, which commonly occurs over much of the tropics. The crust will only contain secondary minerals, which are present there because they are extremely resistant to weathering by downward woving water. Hence soil forming processes can have little effect on the minerals in the crust.

The dead vegetation rapidly attacked by saprophytic organisms and though no quantitative estimates are available, it is probable that the soil animals play a relatively more important role here than in the temperate regions. Further, the organisms decomposing this dead vegetation do not produce humus, in the temperature sense of the word. The soil may contain very high amounts of carbon and nitrogen, but this organic matter has a much lighter colour, or may be almost colouress under natural conditions.

Thus the soil just below the forest floor may be very light in colour, in a light yellow to brown, or may have a bright red colour, yet contain several per cent of organic matter. It seems to be generally true that the humus in all well drained tropical soils is lighter in colour than in the temperate regions, and that many tropical soils with impeded drainage have an intense black colour although they may only contain small amounts of organic matter.

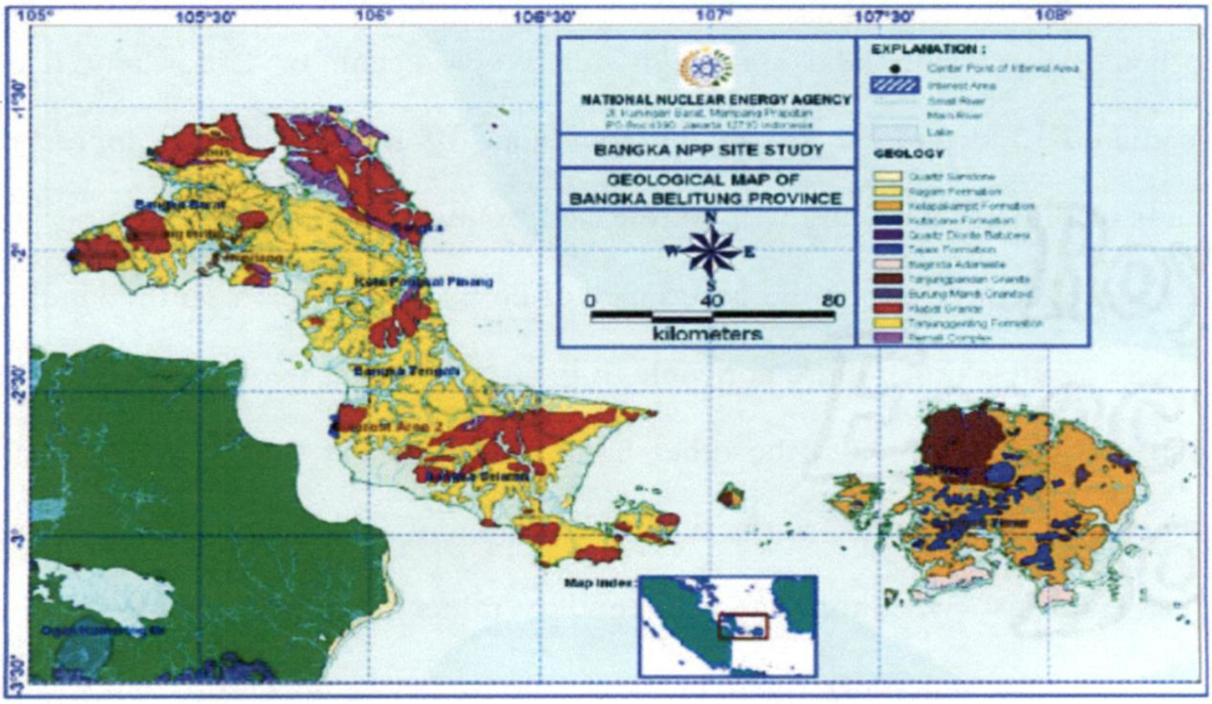


Fig. 3.4. Geological Map of Bangka Belitung Province.

Table 3.3 Geological Colour Chart.

Colour	Description
	Quartz Sandcone
	Ranggam Formation
	Kelapa Kampit Formation
	Siantu Formation
	Quartz Diorite Batubasi
	Tajam Formation
	Baginda Adalemite
	Tanjungpandan Granite
	Burung Mandi Granodiorit
	Klabat Granite
	Tanjunggenting Formation
	Pemali Complex

Another characteristics of tropical soils on old land surface is their extreme poverty in plant nutrients. Such soils may carry luxuriant virgin forest but yet have almost all their supply of plant nutriens present in the living or dead plants and animals or their ephemeral decomposition products. Hence, once such land has been cleared of vegetation and a few crops taken and removed, all the plant nutrients will also have been removed and the soil left in a conditon of extremely low productivity.

The outstanding feature of most chemical analysis that have been made on undisturbed soils in the humid tropics has been the uniformity in the chemical composition of the soil. In so far as the soil weathers it must dissolve away completely, leaving virtually no residue behind. The colour of the soils can be either red or yellow to brown. The red colour probably developed under a climate having a hot annual dry season, whereas the yellow is more common either under a hot uniformly wet climate or under a hot climate in which the hot eather coincides with the rains and the cooler weater with dry season. However, soils devoid of iron have a white to pale yellow or brown colour. The difference in colour is presumably due to the iron being present, immonite, hydrated FeO(OH), under normal humid conditions but being converted to haematite, Fe_2O_3, under hot dry conditions. But whenever the drainage is impeded, the yelow brown colour is usually dominant.

There is evidence that typical podsol can be found in the hot, humid tropics. They have been described as occuring in perneable quarts sand carrying a heath vegetation with a thin layer of acid more on the surface of the sand. There is usually up to 10 to 20 cm. of A_1 horizon, from 20 to 100 cm. of bleached A_2 sand, followed by a B horizon that is enriched with iron an aluminium and may be indurated taken. Table below refers to such a soil in the lowlands of Bangka. Podsol also occure in the uplands of tropical region, at elevations of 6,000 feet or over; when the climate is no longer tropical and the mean annual temperature will about 15^0C instead 25^0C.

Table 3.4. The composition of lowland tropical Podsol from Bangka.

Horizon	A_0	A_1	A_2	B_1	B_2
Depth in cm	0 - 10	10 - 25	25 - 40	40 - 70	70 - 100
Colour	Black	Greyish black	Greyish white	Dark brown	Light brown
pH	2.7	3.9	6.1	3.9	4.6
Per cent clay	-	1.6	0.6	7.2	4.6
Analysis of clay fraction					
SiO_2	48.9	60.6	65.2	18.2	14.0
Al_2O_3	18.8	12.3	10.1	70.7	73.2
Fe_2O_3	6.4	3.1	4.2	4.4	6.5
TiO_2	10.1	14.2	8.6	2.7	2.7
$\frac{SiO_2}{Al_2O_3 + Fe_2O_3}$	3.62	7.17	8.64	0.42	0.31

Source : Note the profile described by H. J. Hardon and quoted in the seventh edition of soil condition as an example of a tropical podsol, refers to a profile at an elevation of 2,000 m. Where the average daily and annual temperature is 14° to 15°C. The mean annual temperature at Bangka is about 26°C.

3.7. Agriculture Condition

Bangka Belitung's primary agriculture commodities are among others: horticulture commodities such as corn, cassava, peanut and varieties of vegetables. Of the land available for rice field (wetlands), they have not been optimally exploited due to the preference of local people to plant pepper which gives higher sales value. This reflects to the availability of land area for rice field as many as 14,988 Ha of which about 3,609 Ha has just been cultivated.

Plantation, according to the business type, the development of plantation sector was divided into two groups, namely Local Community Plantation and big (private/state-owned plantation). The main commodities of Local Community Plantation are among others pepper, coconut, rubber, cocoa, and clove, while big plantations have their own commodities like palm oil which could produce CPO.

The land available for this plantation sector is 559,454 Ha, and about 143,642 Ha (25.6%), was being cultivated.

Fishery, due to its geographic location and surrounded by the sea, Bangka Belitung has abundant maritime and fishery resources. The potency of MSY (Maximum Sustainable Yield) of fishery sectors is 213,625 tonnes per annum, while it has been exploited for 116,680 tonnes per annum (54.62%). The suitable land for fish hatchery is as wide as 114,665 Ha, and it has been utilized about 1,320 Ha. Besides, coastal areas are the ultimate business fields for see weed, shrimp, lobster, flying fish and many others.

3.8. Weather Condition

The main variable of Indonesia's climate is not temperature or air pressure, but rainfall. The almost uniformly warm waters that make up 81 percent of Indonesia's area ensure that temperatures on land remain fairly constant. Split by the equator, the archipelago is almost entirely tropical in climate, with the coastal plains averaging 28°C, the inland and mountain areas between 25°C - 26°C, and the higher mountain regions, 23°C. The area relative humidity ranges between 70 and 90 percent. Winds are moderate and generally predictable, with monsoons usually blowing in from the south and east in June through September and from the northwest in December through March. Typhoons and large scale storms pose little hazard to mariners in Indonesia waters; the major danger comes from swift currents in channels, such as the Lombok and Sape straits. While the intensity of solar radiation in the year 2008 the average varies between 17.3 to 72.5 percent and the air pressure between 1008.3 to 1010.0 mb.

The extreme variations in rainfall are linked with the monsoons. Generally speaking; there is a dry season (April to September), influenced by the Australian continental air masses, and a rainy season (October to March) that is the result of mainland Asia and Pacific Ocean air masses. Local wind patterns, however, can greatly modify these general wind patterns, especially in the islands of central Maluku-Seram, Ambon, and Buru. This oscillating seasonal pattern of wind and rain is related to Indonesia's geographical location as an archipelago between two large continents. In July and August, high pressure over the Australian desert moves winds from that continent toward the northwest. As the winds reach the equator, the earth's rotation causes them to veer off their original course in a northeasterly direction toward the Southeast Asian mainland. During January and February, a corresponding high pressure system over the Asian mainland causes the pattern to reverse. The resultant monsoon is augmented by humid breezes from the Indian Ocean, producing significant amounts of rain throughout many parts of the archipelago.

Prevailing wind patterns interact with local topographic conditions to produce significant variations in rainfall throughout the archipelago. In general, western and northern parts of Indonesia experience the most precipitation, since the north- and westward-moving monsoon clouds are heavy with moisture by the time they reach these more distant regions. Western Sumatera, Java, Bali, the interiors of Kalimantan, Sulawesi, and Papua are the most predictably damp regions of Indonesia, with an average rainfall of 179.3 mm per month or the heaviest rainfall is around 2,500 mm per annum. In part, this moisture originates on strategically located high mountain peaks that trap damp air.

Table 3.5. Rainfalls in Bangka Belitung Province.

Month	Rainfalls (mm)					
	2004	**2005**	**2006**	**2007**	**2008**	**2009**
January	185.4	228.1	163.1	476.3	372.7	294.4
February	196.9	72.2	300.0	168.7	130.9	49.6
March	236.4	211.3	195.4	191.5	206.6	370.3
April	156.6	223.0	394.7	227.7	275.5	95.3
May	175.1	219.6	232.9	279.7	102.8	240.8
June	66.7	155.8	148.7	211.9	118.7	129.7
July	154.1	118.6	55.3	257.6	82.1	155.6
August	2.4	155.9	18.5	58.3	119.8	78.0
September	4.1	177.8	35.6	84.8	120.3	11.8
October	129.2	190.5	20.7	208.9	95.5	94.8
November	151.0	398.3	25.4	240.5	256.3	184.6
December	460.2	410.2	357.9	329.0	244.0	205.4
Average	**159.9**	**213.4**	**163.2**	**227.9**	**177.1**	**159.2**

Source : http://babel.bps.go.id/

Although air temperature changes little from season to season or from one region to the next, cooler temperatures prevail at higher elevations. In general, temperatures drop approximately 1° per 90 meters increase in elevation from sea level with some high altitude interior mountain regions experiencing night frosts. The highest mountain ranges in Papua are permanently capped with snow.

Located on the equator, the archipelago experiences relatively little change in the length of daylight hours from one season to the next; the difference between the longest day and the shortest day of the year is only forty-eight minutes. The archipelago stretches across three time zones: Western Indonesian Time--seven hours in advance of Greenwich Mean Time (GMT)--includes Sumatera, Java, and eastern Kalimantan; Central Indonesian Time--eight hours head of GMT--includes western Kalimantan, Nusa Tenggara, and Sulawesi; and Eastern Indonesian Time--nine hours ahead of GMT-- includes the Maluku and Papua. The boundary between the western and central time zones--established in 1988--is a line running north between Java and Bali through the center of Kalimantan. The border between central and eastern time zones runs north from the eastern tip of Timor to the eastern tip of Sulawesi.

3.9. Land Use Pattern

The identification of land use pattern are housing, agriculture (wet and dry area), plantation, forestry, tourism, industry and mining.

- ✓ Housing, the housing spreading to central of village, and the part of household in the coastal area.
- ✓ Agriculture, basically of the total area in the Bangka Belitung around 25% used for agriculture like rice field (wetlands), plantation (state, private and public owned).
- ✓ Plantation, according to the business type, the development of plantation sector was divided into two groups, namely Local Community Plantation and big (private/state-owned plantation). The main commodities of Local Community Plantation are among others pepper, coconut, rubber, cocoa, and clove, while big plantations have their own commodities like palm oil which could produce CPO. The land available for this plantation sector is 559,454 Ha, and about 143,642 Ha (25.6%), was being cultivated.
- ✓ Forestry, according to the land use was devided into three groups, namely conservation forest (*hutan lindung*), production forest (*hutan produksi*) and convection forest (*hutan konveksi*), the forest plants have a variety of wood such as: Wood Ramin, Meranti, Kapuk, Jelutung, Pulai, Gelam, Bitanggor, Meranti Slough, Cempedak, Mahang, Mangrove and so forth. The land

available for conservation forest is 114,847 Ha, production forest is 494,231 Ha and convection forest is 30,998 Ha.

- ✓ Tourism, generally the coastal area is tourism zone mainly beach and sea tourism.
- ✓ Mining Industry, Bangka Belitung has abundant mining and mineral deposits or known as "World's tin belt". The areas that have been exploited covered 486,445 Ha. Meanwhile, there are some potential resources of C-group minerals like; quartz sand, building construction sand, kaolin, granite, and diabas stone.

3.10. Social Conditions

In 2010, Babel's population was 1,225,058. The biggest population among the regencies was Bangka regency, 277,193 people, while the most density populated was Pangkalpinang City, with its 1,477 people/sq.km. Growth of population in 2010 reached 1.03 % per annum averagely. Table below refers to growth population in Bangka Belitung.

Table 3.6. Growth Population in Bangka Belitung Province.

SNo	Regencies//City	2004	2005	2006	2007	2008	2009	2010
1.	Pangkalpinang	141,185	146,161	150,668	155,250	156,982	160,451	174,838
2.	Bangka	231,793	246,837	256,224	265,859	270,704	275,515	277,193
3.	Western Bangka	140,323	147,855	152,296	156,806	158,433	160,006	175,110
4.	Central Bangka	129,469	133,380	138,261	143,262	145,670	146,266	161,075
5.	Southern Bangka	147,039	148,916	153,874	158,931	161,087	163,200	172,476
6.	Belitung	134,781	132,927	134,819	136,682	138,547	140,376	155,924
7.	Eastern Belitung	88,065	87,380	88,633	89,867	91,103	92,315	106,432
Total		1,014,659	1,045,451	1,076,781	1,108,664	1,124,534	1,140,138	1,225,058
Growth population (%)			1.03	1.03	1.03	1.01	1.01	1.07

Source : Central Statistical Agency, Bangka Belitung Province, 2010.

3.11. Extension Services

3.11.1. Infrastructures

- ✓ Road. In the year 2007, the length of the road was 3,033 km, with 912.12 km of provincial road and 2,120.88 km of Regency/City road in varies condition.
- ✓ Airport. There are two domestic airports, namely Depati Amir Airport in Central Bangka the government has been developing the landing area of its airport with length of landing strip 2,600 m (under construction) and 30 m width and H.A.S. Hanandjoeddin in Tanjung Pandan with length of landing strip 2,000 m and 30 m width.
- ✓ Seaport. There are six seaports in Bangka Belitung. The big seaports are Pangkal Balam, Muntok, Belinyu, Sadai seaports in Bangka, Manggar and Tanjung Pandan in Belitung with the total export and import in these seaports in the year 2000 reached 489,257 tonnes and 65,343 tonnes.
- ✓ Telecommunication. The government provided 23,246 automatic telephone lines unit.
- ✓ Energy and Electricity. In the year 2011, electricity power production reached 91 MW (include 7 MW under construction) in Bangka island and 33 MW (include 5 MW under construction) in Belitung island comes from diesel generating power.
- ✓ Water. All Regencies/City had a water treatment facility with the production, and water requirement presented in Appendix 2.

3.11.2. Agricultural Extension Programmes

It is important to disseminate information about new technologies so that the farmer is able to make use of the latest agricultural developments. There also exists a gap between research findings and the needs of farmers. For technology to be successful, it is important that it should serve a useful purpose to the end user. The institution that bridges the gap between farmers and agricultural research scientists is the Agricultural Extension Service.

The main objective of Agriculture Extension Services is to transmit latest technical know-how to farmers. Besides this, the also focuses on enhancing farmers knowledge about crop techniques and helping them to increase productivity. This is done through training courses, farm visits, on farm trials, clubs, advisory bulletins and the like. Any particular extension services can be described both in terms of both *how* communication takes place and *why* it takes place. Instead there are four possible combinations, each of which represents a different extension paradigm, as follow:

- *Technology Transfer.* This paradigm involves a top-down approach that delivers specific recommendations to farmers about the practices they should adopt.

- *Advisory Work.* This paradigm where government organisations or private consulting companies respond to farmers enquiries with technical prescriptions. It also takes the form of projects managed by donor agencies and NGOs that use participatory approaches to promote pre-determined packages of technology.

- *Human Resource Development.* This paradigm top-down teaching methods are employed, but expected to make their own decisions about how to use the knowledge they acquire.

- *Facilitation for Empowerment.* This paradigm involves methods such as experiential learning and farmer-to-farmer exchanges. Knowledge is gained through interactive processes and the participants are encouraged to make their own decisions.

3.11.3. Fisheries and Marine Sector

Production of freshwater fish (freshwater pond) in Baturusa cerucuk of 751.24 tonnes, West Bangka Regency is the biggest contributor to that is as much as 352.65 tonnes. Produced fish from lakes/reservoirs, rivers/public waters Keramba, floating nets, ponds and marine. Bangka Belitung Province as viewed from the sea oceanography has a very broad and strategic to make the relationship between islands in Indonesia and with foreign countries, reaching 65,301 sq.km or 65,301,000 ha. The waters are very potential for the development of fisheries and marine tourism business development as well as have a variety of the fish, also has a beautiful sea panorama. Some types of fish from marine waters of the Pacific Islands that many fisherman are arrested, Snapper, Karapu, Nila, Crab, Scallop, Shrimp and others.

3.11.4. Mining Sector

So far, Bangka Belitung Island is known as an area that has the potential of large mineral form of tin and is a major tin producer in Indonesia. In addition, Bangka Belitung Province has the potential mineral class "C" include quartz sand, building sand, kaolin, granite, diabes and others scattered throughout the region and it is estimated there are also oil and gas reserves around the northern island of Bangka. Since the year 1709 has been exploited tin mining in Bangka Island, and until now seems to lead is still a mainstay commodity exports. However, the limited reserves of tin deposits, and mining is expected to massively in just 10 years away, except those operated by people with small scale and limited.

3.11.5. Industrial Sector

Industrial development in the seven districts province of Bangka Belitung is intended to expand employment opportunities, leveling opportunities, increased export opportunities in support of local development by utilizing natural resources and energy and human resources. Opportunity to open a range of activities in the field of industry and for that purpose the government provide the maximum opportunity to the public.

The industrial sector industries classified on the large, medium, small and household, the grouping is based on the number of workers who worked in the industry. Industrial firms have a workforce reaching 100 people or more are classified as large industrial enterprises, total employment from 20 to 99 people classified as medium industrial enterprises, and if its workforce is less than 20 people were classified as small industrial enterprises.

3.11.5. Tourism Sector

Tourism is one sector of economic activity that can be relied upon because it can generate income, expand employment, promote regional development become a means of introducing natural beauty, cultural value of local handicrafts and a variety of communities.

The potential in the tourism area which is very dominant in the coastal area of the island is a tourist beach, because the islands of Bangka Belitung is a province that has a coastline of approximately 1,200 km, with a stretch of white sand beaches and beautiful panoramas and some places are decorated diverse variety of rock formations excellent shape developed for tourism.

3.12. Sale of Pesticides

The value of pesticide imports during the period of 20 years on average increased by 10.75%, as in the period 1991-1992 from US$.9,066,000 to US$.12,540,000 or an increase of 14.03%, in the period 1998-1999 experienced an increase of 17.44% from US$.18,589,000 to US$.30,413,000 also increased the value of imports that occurred in the period 2007-2008 amounted to 15.41% from US$.104,040,000 to US$.160,299,000. While the value of export of pesticides during the period of 20 years on average increased by 10.69% as in the period 1988-1989 the export value increased by 18.89% from US$.7,141,000 to US$.13,529,000, the same thing increase experienced by 12.78% which occurred in the period 1995-1996 from US$.13,574,000 to US$.27,671,000 while the smallest percentage of export value occurred in the period 2001-2002 amounted to 8.22% from US$.57,577,000 to US$.59,318,000. As shown in Table 3.7., Fig. 3.5. and Fig. 3.6.

Insectisides import value during the period of 20 years on average increased by 11.82% with the highest percentage occurred in the period 1998-

1999 amounted to 27.31% from US$.1,886,000 to US$.5,150,000, that in the previous period in 1997-1998 export value decreased by 4.02% from US$.5,510,000 to US$.4,486,000. While the export value of insecticides during the period of 20 years on average increased by 10.52% with the highest percentage occurred in the period 1988-1989 amounted to 20.21% from US$.1,238,000 to US$.12,045,000 and the next period is on year 1990-1991 the export value declined significantly from US$.24,343,000 to US$.13,352,000. As shown in Table 3.7., Fig. 3.5. and Fig. 3.6.

Imports value of fungicides during the period of 20 years increased by an average of 13.01% with the highest percentage increase in export value occurred in the period 1992-1993 that is equal to 68.45% from US$.703,000 to US$.4,812,000 whereas the percentage decrease smallest export value occurred in the period in 1991-1992 in the amount of US$.2,881,000 to US$.703,000 or equal to 40.98%. While the export value of fungicides during the next 20 years by an average of 38.79% as in the period 2007-2008 increased by 19.88% from US$.2,626,000 to US$.5,220,000. As shown in Table 3.7., Fig. 3.5. and Fig. 3.6.

Imports value of herbicide during the period of 20 has increased by 18.58% as it is the period 1998-1999 increased by 20.56% from US$.3,062,000 to US$.7,454,000 and in the period 2005-2006 amounted to 11.42% from US$.26,002,000 to US$.29,686,000. While the export value of herbicides during the period of 20 years on average increased by 80.35% as in the period 1996-1997 amounted to 83.29% from US$.1,512,000 to US$.12,593,000. In the periode 2006-2007 and by 17, 10% from US$.32,101,000 to US$.54,907,000. As shown in Table 3.7., Fig. 3.5. and Fig. 3.6.

Table 3.7.

Export and Import value of Pesticides, Insecticides, Fungicides and Herbicides (US$), 1988-2008.

No	Years	Pesticides		Insecticides		Fungicides		Herbicides	
		Import value (1000$)	Export value (1000$)	Import value (1000$)	Export value (1000$)	Import value (1000$)	Export value (1000$)	Import value (1000$)	Export value (1000$)
1	2	3	4	5	6	7	8	9	10
1	2008	160,299	135,414	60,602	66,822	35,550	5,220	57,924	58,944
2	2007	104,040	110,159	37,548	47,219	25,687	2,626	36,071	54,907
3	2006	95,136	89,889	36,178	48,091	25,525	3,002	29,686	32,101
4	2005	81,775	67,038	32,020	32,058	20,507	1,776	26,002	21,897
5	2004	69,124	64,567	24,842	33,317	16,290	1,892	23,631	19,380
6	2003	50,305	48,759	18,102	27,008	16,721	2,250	10,126	14,594
7	2002	43,946	59,318	14,191	30,647	16,693	4,034	8,270	20,350
8	2001	51,715	57,577	16,863	31,887	19,516	5,076	10,191	16,718
9	2000	53,033	70,389	11,690	32,983	20,608	5,724	15,326	29,012
10	1999	30,413	58,087	5,150	30,158	14,226	5,746	7,454	18,360
11	1998	18,589	41,822	1,886	15,131	10,079	4,838	3,062	19,285
12	1997	30,137	35,370	4,486	17,540	11,529	4,198	3,530	12,593
13	1996	35,685	27,671	5,510	19,878	13,600	5,383	5,174	1,512
14	1995	24,248	13,574	5,491	10,307	9,157	82	3,579	2,815
15	1994	20,956	10,698	5,317	10,476	7,913	66	3,180	32
16	1993	17,591	8,357	3,836	8,092	4,812	105	2,433	87
17	1992	12,540	12,167	3,058	12,049	703	84	137	3
18	1991	9,066	15,099	1,380	13,352	2,881	59	1,738	1,596
19	1990	10,052	25,518	1,196	24,343	2,718	-	3,299	1,195
20	1989	11,244	13,529	2,213	12,045	1,657	40	5,134	21
21	1988	10,660	7,141	65	1,238	2,567	-	5,368	40

Source : http://faostat.fao.org/

Fig. 3.5.
Import value of Pesticides, Insecticides, Fungicides and Herbicides, 1988-2008.

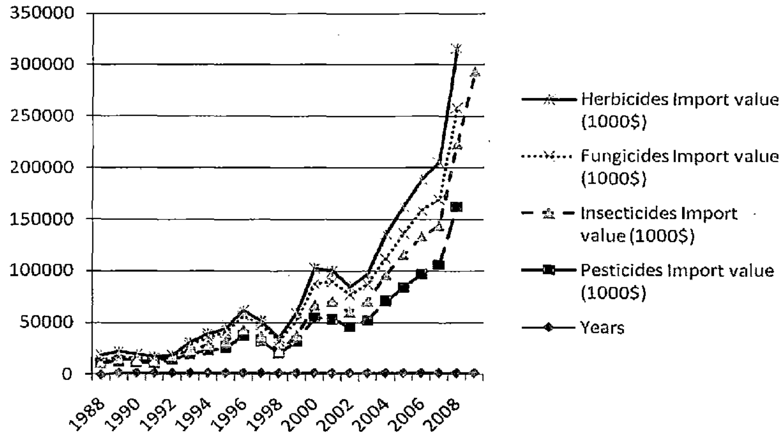
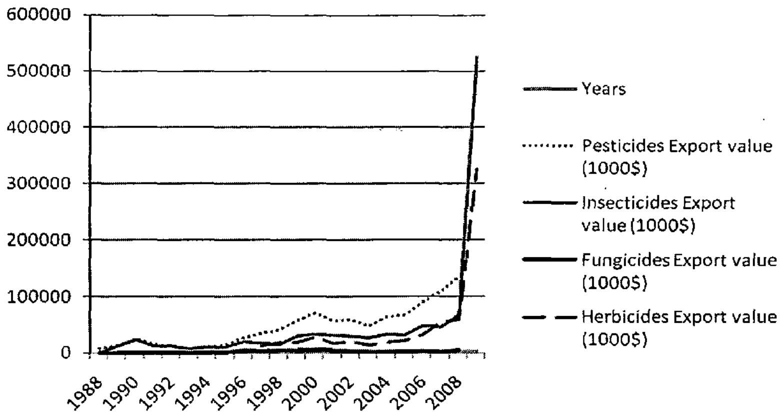


Fig. 3.6.
Export value of Pesticides, Insecticides, Fungicides and Herbicides, 1988-2008.



3.13. Sale of Fertilizers

Main producer of fertilizer in Indonesia which is a national company consisting of Pupuk Sriwijaya Co. Ltd. (PUSRI), Petrokimia Gresik Co. Ltd., Pupuk Kujang Co. Ltd., Pupuk Kalimantan Timur Co. Ltd. (KALTIM), Pupuk Iskandar Muda Co. Ltd. (PIM), and Asean Association Fertilizer Co. Ltd. (AAF).

Pupuk Sriwijaya, Co. Ltd. Ammonia and Urea production during the period 1974-1994 Ammonia production capacity of 1,499,000 tonnes and 2,280,000 tonnes of urea. Petrokimia Gresik Co. Ltd. in the period 1972-1986 produces ZA/AS (Ammonium sulfate) at 650,000 tonnes, and in 1979 produced TSP/SP36 fertilizer (Triple Super Phosphate) amounted to 1,000,000 tonnes, while in 1994 production amounted to 445,000 tonnes Ammonia and Urea at 460,000 tonnes. Pupuk Kujang Co. Ltd. in 1979 to produce ammonia and urea, each for 713,000 tonnes and 1,156,000 tonnes. Pupuk KALTIM Co. Ltd. in the period 1989-2002 to produce ammonia and urea, each of which amounted to 1,848,000 tonnes and 2,980,000 tonnes. Meanwhile, Pupuk Iskandar Muda Co. Ltd. Ammonia and urea production in 2005 amounted to 396,000 tonnes and 570,000 tonnes. Asean Aceh Fertilizer (AAF) in 1983 to produce ammonia and urea, each for 396,000 tonnes and 660,000 tonnes. As shown in Table 3.8.

The quantity of phosphate fertilizer production in the period 2002-2008 the average increased by 11.93%, a significant increase occurred in the period 2002-2003 from 254,669 tonnes to 526,620 tonnes, whereas in the period 2007-2008, an increase of 13.73% from 349,787 tonnes to 480,162 tonnes.

Table 3.8.
Production capacity of fertilizer (ton/year).

S.No	Manufactures	Ammonia	Urea	TSP/SP36 (Triple Super Phosphat)	ZA/AS (Amonium Sulfat)
1.	Pupuk Sriwijaya, Co. Ltd.				
	1994 PUSRI II	446,000	570,000	-	-
	1974 PUSRI III	261,000	570,000	-	-
	1976 PUSRI IV	396,000	570,000	-	-
	1977 PUSRI IB	396,000	570,000	-	-
	Amount	**1,499,000**	**2,280,000**	-	-
2.	Petrokimia Gresik. Co. Ltd.				
	1994 Urea Petro	445,000	460,000	-	-
	1979 SP36 Unit I	-	-	500,000	-
	1979 SP36 Unit II	-	-	500,000	-
	1972 ZA Unit 1	-	-	-	200,000
	1984 ZA Unit 2	-	-	-	250,000
	1986 ZA Unit 3	-	-	-	200,000
	2000 Phonska	-	-	-	-
	Amount	**445,000**	**460,000**	**1,000,000**	**650,000**
3	Pupuk Kujang. Co. Ltd.				
	1979 Kujang I	383,000	586,000	-	-
	1979 Kujang IB	333,000	570,000	-	-
	Amount	**713,000**	**1,156,000**	-	-
4.	Pupuk Kaltim. Co. Ltd.				
	1989 KALTIM 1	594,000	700,000	-	-
	1989 KALTIM 2	594,000	570,000	-	-
	1989 KALTIM 3	330,000	570,000	-	-
	2002 KALTIM 4	330,000	570,000	-	-
	1999 POPKA	-	570,000	-	-
	Amount	**1,848,000**	**2,980,000**	-	-
5.	Pupuk Iskandar Muda. Co, Ltd.				
	1984 PIM 1	366,000	600,000	-	-
	2005 PIM 2*)	396,000	570,000	-	-
	Amount	**762,000**	**1,170,000**	-	-
6.	Asean Association Fertilizer. Co. Ltd.				
	1983 AAF**)	396,000	660,000	-	-
	Amount	**396,000**	**660,000**	-	-
	Total	**5,663,000**	**8,706,000**	**1,000,000**	**650,000**

*)During construction, commisioning and start-up estimated on 3[th] Q 2005.
**)Since 2004 the plant was closed because since 2003 AAF experience storage of natural gas supply to the plant. At the moment the status of the company still within discussion by share holder within ASEAN Governments i.e. Indonesia, Malaysia, Thailand, Philipines and Singapore.

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2007.

The quantity of imported phosphate fertilizers in the period 2002-2008 by an average of 12.44% with the highest percentage occurred in the period 2003-2004 amounted 18.38% from 74,312 tonnes to 136,590 tonnes. The export capacity of phosphate fertilizer in this period by an average of 14.58% with the highest percentage occurred in the period 2005-2006 amounted to 34.59% and lowest in the period 2004-2005 amounted to 3.53% from 925 tonnes to 1,485 tonnes. The capacity of phosphate fertilizer consumption in the period 2002-2008 by an average of 11.44% as in 2006-2007 amounted to 10.87% from 354,675 tonnes to 385,649 tonnes. As shown in Table 3.9.

Table 3.9.
Production quantity, import, export and consumption of Phosphat fertilizer (ton/year), 2002-2008.

Phosphate fertilizers (P_2O_5 total nutriens)				
Year	Production quantity in nutriens (tonnes of nutriens)	Import quantity in nutriens (tonnes of nutriens)	Export quantity in nutriens (tonnes of nutriens)	Consumption in nutriens (tonnes of nutriens)
2008	480,162	280,186	8,262	383,219
2007	349,787	169,524	3,778	385,049
2006	307,735	167,199	5,137	354,075
2005	345,063	109,081	1,485	327,794
2004	318,134	136,590	925	318,134
2003	526,620	74,312	2,630	526,620
2002	254,669	117,854	6,461	254,669

Source : http://faostat.fao.org/

The quantity of nitrogen fertilizer production in the period 2002-2008 an average of 10.86% per year, the highest percentage increase occurred in the period 2004-2005 amounted to 12.45% from 2,309,142 tonnes to 2,3875,658 tonnes and the lowest in the period of 2005-2006 amounted to 9.77% from 2,875,658 tonnes to 2,808,307 tonnes. The quantity of nitrogen fertilizer imports during the period 2002-2008 with an average of 10.99%, with the highest percentage occurred in the period 2007-2008 amounted to 15.09% from 2,947,267 tonnes to 3,189,117 tonnes, while the lowest occurred in the period 2003-2004 amounted to 6.98% from 139,436 tonnes to 96,678 tonnes. While the export quantity of nitrogen fertilizer in the period 2002-2008 an average of 31.16%. The consumption of nitrogen fertilizer during the period of 2002-2008 by an average of 10.69%. As shown in Table 3.10.

Table 3.10.
Production quantity, import, export and consumption of Nitrogen fertilizer (ton/year), 2002-2008.

Nitrogen fertilizers (N total nutriens)				
Year	Production quantity in nutriens (tonnes of nutriens)	Import quantity in nutriens (tonnes of nutriens)	Export quantity in nutriens (tonnes of nutriens)	Consumption in nutriens (tonnes of nutriens)
2008	3,189,117	237,212	89,799	2,675,620
2007	2,947,267	157,164	318,966	2,503,269
2006	2,808,307	181,157	20,819	2,435,519
2005	2,875,658	143,436	310,231	2,411,944
2004	2,309,142	96,678	199,051	2,309,142
2003	2,119,780	139,436	577,373	2,119,780
2002	1,974,661	178,925	513,723	1,974,661

Source : http://faostat.fao.org/

Potash fertilizer import quantity in the period 2002-2008 increased an average of 12.80% per year, with the highest percentage occurred in the period 2003-2004 amounted to 18.40% from 332,709 tonnes to 612,261 tonnes and the lowest percentage occurred in the period 2004-2005 9.35% from 612,261 tonnes to 572,301 tonnes. While the average Potash fertilizer consumption in the period

2002-2008 amounted to 13.24% with the highest percentage occurred in the period 2003-2004 amounted to 20.95% from 290,747 tonnes to 605,135 tonnes and the lowest percentage by 9.26% from 609,135 tonnes to 564,174 tonnes which occurred in the period 2004-2005. As shown in Table 3.11.

Table 3.11.
Production quantity, import, export and comsumption of Potash fertilizer (ton/year), 2002-2008.

Potash fertilizers (K_2O total nutriens)				
Year	Production quantity in nutriens (tonnes of nutriens)	Import quantity in nutriens (tonnes of nutriens)	Export quantity in nutriens (tonnes of nutriens)	Consumption in nutriens (tonnes of nutriens)
2008	-	1,175,436	2,543	1,130,750
2007	-	832,007	1	810,740
2006	-	625,525	632	607,749
2005	-	572,301	-	564,174
2004	-	612,261	-	609,135
2003	-	332,709	2,312	290,747
2002	-	311,184	6,443	259,892

Source : http://faostat.fao.org/

The development of urea production in Indonesia produced by PT PUSRI, PT Pupuk Kujang, PT Pupuk Kaltim, PT Petrokimia Gresik, PT Pupuk Iskandar Muda and PT Asean Aceh Fertilizer during the period of 45 years, the average since the year 1963-2007 increased by 13.09% per year with the lowest percentage occurred in the period 1967-1968 from 95,528 tonnes to 84,170 tonnes, while the highest percentage occurred in the period 1974-1975 amounted to 19.41% from 207,375 tonnes to 402,430 tonnes.

The capacity production of urea to PT PUSRI during the period 1963-2007 amounted to 55,185,948 tonnes with an average growth of 12.84% per year or a total of 1,226,354 tonnes/year. Urea production capacity to PT Pupuk Kujang of 16,868,115 tonnes with an average growth of 7.78% per year or a total of 374,847 tonnes/year. For a production capacity of PT Kaltim Fertilizer for 40,675,636 tonnes with an average of 6.01% per annum or a total of 903,903 tonnes/year. While PT Petrokimia Gresik of 4,404,947 tonnes with an average of 8.58% annually or a total of 97,888 tonnes/year. As for production capacity of PT Iskandar Muda Fertilizer for 11,839,099 tonnes with an average of 4.95% per annum or a total of 253,659 tonnes/year. The PT AAF production capacity of 11,414,644 tonnes with an average of 7.02% or a total of 253,659 tonnes/year. As shown in Table 3.12.

Table 3.12.
Growth of urea fertilizer production based on producer (ton), 1963-2007.

No.	Years	PUSRI	KUJANG	KALTIM	PETRO KIMIA	PIM	AAF	TOTAL
1.	1963	9,723	-	-	-	-	-	9,723
2.	1964	103,547	-	-	-	-	-	103,547
3.	1965	95,120	-	-	-	-	-	95,120
4.	1966	93,015	-	-	-	-	-	93,015
5.	1967	93,337	-	-	-	-	-	93,337
6.	1968	95,527	-	-	-	-	-	95,528
7.	1969	84,170	-	-	-	-	-	84,170
8.	1970	98,407	-	-	-	-	-	98,407
9.	1971	104,750	-	-	-	-	-	104,750
10.	1972	108,222	-	-	7,830	-	-	116,052
11.	1973	108,267	-	-	13,896	-	-	122,163
12.	1974	191,064	-	-	16,311	-	-	207,385
13.	1975	389,846	-	-	12,584	-	-	402,430
14.	1976	385,950	-	-	906	-	-	386,856
15.	1977	806,565	-	-	12,487	-	-	819,052
16.	1978	1,364,042	72,316	-	14,872	-	-	1,451,230
17.	1979	1,373,295	438,027	-	13,611	-	-	1,824,933
18.	1980	1,479,296	558,131	-	6,042	-	-	2,043,469
19.	1981	1,478,190	527,271	-	15,285	-	-	2,020,746
20.	1982	1,430,011	514,104	-	5,832	-	-	1,949,947
21.	1983	1,620,608	578,311	-	6,214	-	55,800	2,260,933
22.	1984	1,638,413	577,733	140,500	-	470	548,502	2,905,618
23.	1985	1,576,592	494,094	400,261	-	565,969	548,419	3,585,335
24.	1986	1,527,737	645,538	580,412	-	636,695	629,272	4,019,654
25.	1987	1,466,712	552,098	852,768	-	588,742	572,190	4,032,510
26.	1988	1,381,326	581,590	1,017,032	-	602,256	574,580	4,156,784
27.	1989	1,473,040	562,463	1,636,732	-	596,364	591,900	4,860,499
28.	1990	1,505,075	580,901	1,712,097	-	604,800	647,659	5,050,532
29.	1991	1,571,840	561,242	1,716,440	-	581,913	541,760	4,973,195
30.	1992	1,441,795	570,127	1,710,131	-	582,908	615,310	4,920,271
31.	1993	1,477,970	585,021	1,827,607	-	583,075	659,051	5,132,724
32.	1994	1,667,480	536,325	1,815,048	153,558	568,808	547,891	5,289,110
33.	1995	2,036,760	607,803	1,713,308	368,849	600,055	567,961	5,894,735
34.	1996	2,180,780	596,425	1,849,700	300,423	619,803	652,646	6,199,777
35.	1997	2,112,990	600,769	1,856,051	400,997	639,079	695,826	6,305,712
36.	1998	2,223,456	511,115	1,833,998	286,545	636,233	663,367	6,154,714
37.	1999	1,997,260	560,142	1,904,300	271,122	550,836	685,654	5,969,314
38.	2000	1,924,820	580,030	2,237,595	341,434	664,201	586,798	6,334,878
39.	2001	2,005,250	552,646	2,104,261	313,116	217,784	122,832	5,315,889
40.	2002	2,032,680	552,984	2,081,827	151,066	586,035	601,629	6,006,221
41.	2003	2,053,410	597,597	2,023,321	260,176	491,016	305,598	5,731,118
42.	2004	2,187,550	526,899	2,272,289	344,356	336,321	-	5,667,415
43.	2005	2,045,860	537,563	2,665,021	404,364	195,847	-	5,848,655
44.	2006	2,051,250	851,579	2,214,961	331,677	205,225	-	5,654,692
45.	2007*	1,046,472	428,470	1,254,988	175,697	92,332	-	2,997,959

*Production from January to June 2007
PUSRI = Pupuk Sriwijaya; KUJANG = Pupuk Kujang; KALTIM = Pupuk Kalimantan Timur
PETROKIMIA = Pupuk Petrokimia Gresik; PIM = Pupuk Iskandar Muda
AAF = Asean Association of Fertilizer (Pupuk Asean)

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2007.

Table 3.13.
Growth production of fertilizer ZA/AS, TSP/SP36 and NPK (ton/year), 1972-2007.

S.No.	Year	ZA/AS[1)]	TSP/SP36[2)]	NPK
1.	1972	29,390	-	-
2.	1973	119,623	-	-
3.	1974	121,767	-	-
4.	1975	122,471	-	-
5.	1976	75,033	-	-
6.	1977	92,371	-	-
7.	1978	141,141	-	-
8.	1979	147,855	114,336	-
9.	1980	180,773	465,018	-
10.	1981	195,345	559,151	-
11.	1982	209,609	577,386	-
12.	1983	208,021	783,616	-
13.	1984	302,127	1,001,781	-
14.	1985	475,581	1,007,070	-
15.	1986	581,648	1,116,909	-
16.	1987	260,601	1,203,607	-
17.	1988	573,842	1,200,403	-
18.	1989	633,918	1,198,445	-
19.	1990	659,817	1,279,864	-
20.	1991	542,722	1,041,802	-
21.	1992	619,662	1,248,763	-
22.	1993	541,700	1,299,000	-
23.	1994	604,800	1,160,000	-
24.	1995	642,836	809,678	-
25.	1996	663,125	1,113,965	417
26.	1997	522,948	868,389	9,885
27.	1998	324,094	616,490	297
28.	1999	510,201	728,658	1,072
29.	2000	533,231	587,988	19,638
30.	2001	515,455	654,678	63,492
31.	2002	426,965	520,855	83,011
32.	2003	479,281	687,657	113,842
33.	2004	572,599	763,225	202,000
34.	2005	644,321	819,701	274,478
35.	2006	631,645	647,868	-
36.	2007[3)]	330,181	316,361	207,424

[1)] Zwavelzure ammoniak/ Ammonium sulfat
[2)] Triple Super Phosphate
[3)] Production on Januari - June 2007

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2007.

The development of urea fertilizer sales in the period 1987-2005 was dominated by 5 major players such as PT. Pusri, PT. Pupuk Kujang, PT. Pupuk Kaltim, PT. Pupuk Iskandar Muda and PT. Petrokimia Gresik during this period total sales amounted to 6,744,630 tonnes with an average growth of 10.64% per annum or a total of 354,981 tonnes per year. The capacity of the highest sales of 2,680,506 tonnes by PT Pusri with an average increase 9.71% per annum or a total of 141,079 tonnes per year, then the capacity of sales amounted to 2,476,508 tonnes with an average growth of 10.54% per annum or 130,343 tonnes per year by PT. Kaltim Fertilizer and successively by PT. Pupuk Kujang amounted to 1,098,414 tonnes with a growth of 11.59% per annum, PT. Pupuk Iskandar Muda 272,676 tonnes per year with a growth of 6.11% per year and PT. Petrokimia Gresik with sales of capacity 216,526 tonnes with an average of 11,396 tonnes per annum. As shown in Table 3.14.

Table 3.14.
Growth sale of urea fertilizer (ton), 1987-2005.

S.No.	Years	PUSRI	KUJANG	KALTIM	PIM	PETRO KIMIA	TOTAL
1.	1987	141, 649	-	-	-	-	141,649
2.	1988	201,068	-	-	-	-	201,068
3.	1989	209,581	-	3,390	-	-	212,971
4.	1990	247,051	-	-	-	-	247,051
5.	1991	119,973	1,570	100,216	9,000	-	230,759
6.	1992	122,308	2,409	138,650	15,950	-	279,317
7.	1993	137,119	3,883	159,552	18,795	-	319,349
8.	1994	124,664	16,765	116,470	19,450	12,121	289,470
9.	1995	139,232	32,738	112,045	14,860	34,850	333,735
10.	1996	127,896	35,067	121,215	21,664	37,771	343,613
11.	1997	146,307	38,488	201,631	26,950	44,530	457,906
12.	1998	156,976	43,566	223,385	24,250	30,488	478,665
13.	1999	99,699	40,186	161,734	24,325	31,736	357,680
14.	2000	93,070	141,649	243,847	6,400	-	484,966
15.	2001	117,218	201,068	112,926	925	-	432,137
16.	2002	125,504	209,581	140,608	-	-	475,793
17.	2003	101,299	118,631	180,069	51,646	-	451,645
18.	2004	139,892	112,813	60,770	13,461	30	326,966
19.	2005	130,000	100,000	400,000	20,000	25,000	675,000

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2006.

Development of fertilizer demand for the agricultural sector during the period of 32 years since the year 1975-2006 as a whole amounted to 140,864,017 tonnes, amounting to 91,471,685 tonnes of urea fertilizer with an average growth of 9.45% or 2,858,490 tonnes per year or 6.49% of the total, next is fertilizer AZ/AS (Zwalvelzure ammonia/Ammonium sulfate) of 13,884,818 tonnes, or a growth of 9.46% per year is equivalent to 433,901 tonnes per year or 0.99% of the total, while for fertilizer TSP/SP36 (Triple super phosphate/Super phosphate36) of 24,440,546 tonnes with an average growth of 9.95% or 763,767 tonnes per year or equal to 1.74% of the total, while for the development of KCl fertilizer needs in this period amounted to 11,066,968 tonnes or average growth of 12.34% per annum or a total of 345,834 tonnes per year in other words contributed for 0.79% of the total. As shown in Table 3.15.

The development of export quantity of urea fertilizer during the period of 29 years in the period 1977-2005 amounted to 36,069,857 tonnes, or an average of 1,243,788 tonnes per year with an average growth of 15.73% per annum. PT Pusri with export capacity of 6,512,550 tonnes, or an average of 224,571 tonnes per year. PT Pupuk Kujang with export capacity of 2,006,474 tonnes, or an average of 69,189 tonnes per year with the percentage growth of 6.98%. PT Pupuk Kaltim Fertilizer with export capacity of 9,589,641 tonnes or an average of 330,677 tonnes per year with the percentage growth of 15.79% per annum. While PT AAF export capacity of 8,260,975 tonnes with an average of 284,861 tonnes per year or a growth of 6.40% per year. PT Pupuk Iskandar Muda with export capacity of 4,948,216 tonnes, or an average of 170,628 tonnes per year with the percentage growth of 12.16%. As for PT Petrokimia Gresik with export capacity of 4,752,001 tonnes or a total of 163,862 tonnes per year with the percentage growth of 13.09% per annum. As shown in Table 3.15.

Table 3.15.
Development needs of fertilizer for the agricultural sector (ton), 1975-2006.

S.No.	Year	UREA	AS/ZA	TSP/SP36	KCL	TOTAL
1.	1975	385,662	86,000	128,526	34,413	624,601
2.	1976	348,554	136,800	98,117	24,285	602,756
3.	1977	639,374	168,000	135,404	69,420	1,012,198
4.	1978	827,790	170,400	224,612	108,998	1,331,800
5.	1979	1,400,952	195,900	266,425	122,058	1,985,335
6.	1980	1,740,551	220,000	483,591	123,311	2,567,453
7.	1981	2,167,227	148,487	732,141	46,454	3,094,409
8.	1982	2,068,530	331,300	712,697	88,365	3,170,892
9.	1983	2,380,522	354,046	834,411	179,151	3,748,130
10.	1984	2,609,197	407,646	951,564	251,955	4,220,362
11.	1985	2,604,468	474,896	1,046,967	290,411	4,416,742
12.	1986	2,738,241	475,690	1,175,701	267,353	4,626,985
13.	1987	2,795,874	553,271	1,190,528	369,734	4,909,407
14.	1988	2,916,466	589,356	316,432	478,463	4,300,717
15.	1989	2,925,421	587,794	1,278,428	457,259	5,248,902
16.	1990	2,977,591	600,307	1,262,789	509,857	5,350,544
17.	1991	2,036,627	606,355	1,255,941	444,195	4,343,118
18.	1992	3,410,348	607,702	1,290,085	481,594	5,789,729
19.	1993	3,094,802	639,473	1,173,158	365,675	5,273,108
20.	1994	3,288,466	614,553	1,124,500	302,080	5,329,632
21.	1995	3,710,455	652,999	1,069,909	403,900	5,837,263
22.	1996	3,917,858	588,192	900,184	375,293	5,781,627
23.	1997	3,323,601	350,503	663,478	350,270	4,687,852
24.	1998	4,289,648	407,898	868,837	172,133	5,738,516
25.	1999	3,140,033	243,906	394,949	380,000	4,158,888
26.	2000	3,959,656	507,005	612,260	400,000	5,489,921
27.	2001	3,934,985	511,170	645,388	326,920	5,418,463
28.	2002	4,276,137	606,529	600,991	450,000	5,930,657
29.	2003	4,369,953	675,511	784,204	266,502	6,096,170
30.	2004	4,361,450	456,129	813,318	181,909	6,023,806
31.	2005	4,321,398	476,000	722,300	155,000	5,674,698
32.	2006	4,409,818	551,000	682,700	190,000	5,833,518

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2007.

Table 3.16.
Development exports of urea fertilizer (ton), 1977-2005.

S.No.	Year	PUSRI	KUJANG	KALTIM	AAF	PIM	PETRO KIMIA	TOTAL
1.	1977	400,195	-	-	-	-	-	400,195
2.	1978	30,462	-	-	-	-	-	30,462
3.	1979	299,299	-	-	-	-	-	299,299
4.	1980	162,440	-	-	-	-	-	162,440
5.	1981	38,902	-	-	-	-	-	38,902
6.	1982	55,000	20,300	-	-	-	-	75,300
7.	1983	262,505	53,720	-	-	-	-	316,225
8.	1984	5,500	-	-	197,100	-	-	202,600
9.	1985	790,287	-	-	244,593	-	-	1,034,880
10.	1986	736,816	216,990	59,282	295,672	204,868	-	1,523,628
11.	1987	302,155	69,562	73,744	462,295	115,517	-	1,023,273
12.	1988	158,322	94,250	216,863	447,042	131,857	-	1,048,334
13.	1989	190,695	178,943	676,180	192,252	155,496	-	1,693,566
14.	1990	175,480	153,537	517,537	570,824	180,541	-	1,598,258
15.	1991	273,870	142,442	735,366	470,475	150,653	-	1,772,806
16.	1992	101,341	82,800	357,600	531,157	259,668	-	1,333,667
17.	1993	210,229	98,190	315,595	614,394	282,542	-	1,520,950
18.	1994	174,866	159,425	409,328	501,991	379,098	106,500	1,731,208
19.	1995	392,384	205,423	380,476	506,378	300,515	185,064	1,970,240
20.	1996	189,225	101,488	301,167	630,498	208,955	102,800	1,634,133
21.	1997	519,726	250,552	397,386	668,656	310,330	214,046	2,360,696
22.	1998	34,579	40,197	410,306	648,469	395,973	41,830	1,571,354
23.	1999	272.653	21,882	917,459	650,403	460,764	5,626	2,328,787
24.	2000	99,875	57,836	701,737	567,028	420,482	73,107	1,920,066
25.	2001	83,409	35,977	641,898	61,715	130,079	67,798	1,020,876
26.	2002	31,086	22,960	564,785	-	203,894	-	822,725
27.	2003	221,254	-	647,565	-	77,983	-	946,792
28.	2004	-	-	465,367	-	-	30	465,397
29.	2005	100,000	-	800,000	-	570,000	-	1,470,000

Source : Asosiasi Produsen Pupuk Indonesia (APPI), *Indonesia Fertilizers Producer Association*, 2006.

Distribution of fertilizer for the agricultural sector in 2006 as a whole amounted to 4,182,641 tonnes or a total of 126,747 tonnes for each province as a percentage of 19.64%, consisting of urea fertilizer at 2,850,441 tonnes or a total of 86,377 tonnes/province or equal to 20.31%, TSP/SP36 fertilizer (Triple Super Phosphate) of 571,258 tonnes per year or a total of 17,311 tonnes for each province, while the ZA/AS (Zwalvelzure ammonia/Ammonium sulphate) amounted to 507,848 tonnes or a total of 15,389 tonnes/province, while fertilizer NPK amounted to 253,094 tonnes with an average of 7,670 tonnes or equivalent to 21.58% in each province, with the highest distribution in East Java province amounted to 1,173,692 tonnes or 2.81% of the total, followed by Central Java amounted to 795,821 tonnes or equal to 1.90% of the total, and West Java 734,060 tonnes or at 1.76% of the total. As shown in Table 3.17.

Table 3.17.
Distribution of fertilizers for agricultural sector (ton), 2006.

S.No.	Provinces	Urea	SP36	ZA/AS	NPK	Total
1.	Nangro Aceh D	36,742	13,423	2,300	1,803	54,268
2.	Northern Sumatera	108,657	26,999	31,529	13,514	180,699
3.	Western Sumatera	42,856	23,550	13,300	8,019	87,725
4.	Jambi	27,470	5,638	1,513	1,379	36,000
5.	Riau	52,822	9,069	5,458	3,990	71,339
6.	Bengkulu	9,680	5,207	2,143	1,136	18,166
7.	Southern Sumatera	90,584	26,134	3,509	4,631	124,858
8.	Bangka Belitung	-	985	762	984	2,731
9.	Lampung	147,485	29,309	6,503	9,883	193,180
10.	DKI Jakarta	-	-	-	-	-
11.	Banten	49,640	12,670	3,173	4,355	69,838
12.	Western Java	550,833	100,252	47,560	35,415	734,060
13.	DI Yogyakarta	44,792	5,535	7,400	4,450	62,177
14.	Central Java	549,017	106,922	94,765	45,117	795,821
15.	Eastern Java	722,606	130,218	234,562	86,306	1,173,692
16.	Bali	40,701	4,625	8,124	7,155	60,605
17.	Western Kalimantan	21,505	5,773	242	4,098	31,618
18.	Cental Kalimantan	7,689	2,251	17	541	10,498
19.	Southern Kalimantan	23,378	6,425	948	2,752	33,503
20.	Eastern Kalimantan	8,724	4,240	874	1,640	15,478
21.	Northern Sulawesi	15,287	3,619	188	2,873	21,967
22.	Gorontalo	6,044	835	570	1,908	9,357
23.	Central Sulawesi	27,267	3,039	3,990	911	35,207
24.	Southeast Sulawesi	13,686	4,057	1,698	491	19,932
25.	Southern Sulawesi	158,508	23,054	28,969	7,189	217,720
26.	NTB	75,555	9,040	5,402	1,858	91,855
27.	NTT	13,733	4,487	67	255	18,542
28.	Maluku	1,204	18	22	41	1,285
29.	Papua	3,347	998	188	142	4,675
30.	Northern Maluku	629	176	-	88	893
31.	Western Papua	-	158	89	90	337
32.	Western Sulawesi	-	2.552	2,983	800	6,335
33.	Riau Archipelago	-	-	-	-	-
	Indonesia	**2,853,441**	**571,258**	**508,848**	**253,814**	**4,187,361**

Source : Directorate General of Horticulture, Ministry of Agriculture, Indonesia, 2007.

3.14. Land Reclamation

Land reclamation or Land rehabilitation is also the process of cleaning up a site that has sustained environmental degradation, such as those by natural cause (desertification) and those caused by human activity (strip mining). Land reclamation is often done in these sites to allow for some form of human use (such as a housing development) or to restore that area back to its natural state as a wildlife habitat home.

Bangka is the largest tin producing island in Indonesia. Sand tin tailing may have 95% sand, C-organics less than 2%, cation exchange capacity less than 1%, and its soil temperature may reach 45°C. The core activities of land reclamation are reforestation, regreening of non forest area and economical empowerment of community living in and around forest area. Critical Lands Critical land refers to a piece of land severely damaged due to its lost of vegetation cover hence its functions as water retention, erosion control, nutrient cycling, micro climate regulator and carbon retention is completely depleted. Based upon its vegetation condition, the land could be classificated as; very critical, critical, slight critical, potential critical and normal condition.

S.No.	Activities	Description
1.	Reforestation of Protection Forest	Reforestation of protection forest is intended to rehabilitate the critical land inside protection forest or watershed to improve their ecological and hydrological function. The activities were conducted with active participation of local communities who live nearby the target area.
2.	Regreening	Regreening is an effort to rehabilitate critical lands outside forest area by planting trees and implementing soil conservation practices. It aims to improve land productivity and hydrological function. The regreening activities may be implemented into a number of schemes.
3.	Community forest	This activity is addressed to the degraded area belongs to community located outside forest area.

		Multi Purpose Trees Species, fruit trees, fuel woods are mainly planted in this area. The objectives of this scheme are to facilitate economic improvement, sustainable forest production for the community while improving soil fertility and environmental condition.
4.	Village Nursery Development	Village Nursery is a temporary nursery, developed by farmer groups of the throughout villages in response to their demand of seedlings for regreening activities.
5.	Construction of Gully Plug	Gully Plug is one of soil conservation techniques that serve to control a gully or valley through construction of a small water permeable dam across the gully made of rock gabion, wood/bamboo riprap, or concrete structure. The benefits of a gully plug are, among others: • improve of degraded lands caused by accelerated water erosion that produced a gully, • prevent of expansion of land degradation due to widening of gullies, • control erosion and sedimentation therefore minimizing sedimentation and flooding of the downstream areas, • improve of water regime of the surrounding area.
6.	Construction of infiltration well	Infiltration well is a technical engineering method of water conservation consisting of a hole dug at a certain depth in the ground to collect rainwater falling from the roof or a non permeable surface to let it penetrate the surrounding ground.
7.	Construction of infiltration well	Infiltration well is a technical engineering method of water conservation consisting of a hole dug at a certain depth in the ground to collect rainwater falling from the roof or a non permeable surface to let it penetrate the surrounding ground.
8.	Rehabilitation of Terraces	Terrace is a soil conservation structure constructed by digging and filling of dirt to form a tillable surface, end bund and drainage ditch following the contour line, complemented with other structures such as waterway and drop structures perpendicular to the contour line. The physical target of terrace construction is to make the land intensively tillable for annual and or perennial crop, at a variety of slope gradient depending upon soil physical properties and local climate condition.
9.	Mangrove Forest Development	Mangrove forest is forest whereby occur in a transitional zone between land and marine ecosystems and is important for protection of coastal region, serve as sediment retainer and provide environmental balance between the two regions.
10.	Development of Community-Owned Forest	Community-owned forest is a piece of forest that belong to community with minimum size of 0.25

		ha and having canopy of woody trees or other plants with more than 50 % tree's crown cover or other plant which planted at the first year minimum density of 500 trees per hectar. Community-owned forest management is implemented through the development of various management units. A unit consists of several farmer groups with total area of at least 900 ha. Community-owned forest management can be developed on lands with ownership right or other rights outside the forest area that meets the requirement for community-owned forest development.

3.15. Effluent Use in Agriculture

River naturally has a role as a supplier of water from the mainland towards the sea. Water during the still on land before entering the sea is very necessary for the needs of human life, terrestrial plants and animals on land (Utomo, 2004). According to Arsyad (2000) that the river water comes from rain that flows into the river as surface flow, water flow beneath the surface, the flow of underground water and grains of rain that falls directly into the river channel. River flow rates will go up after the rains are adequate, then going down again after the rain finished. The flow of river water tends to one direction, from upstream to downstream, so what happens upstream section will result in the downstream river. The water coming from upstream will take nutrients originating from ground water seepage into the river downstream, so that in the downstream river will be higher nutrient content thus part of the river downstream will generally be more fertile. However if in the upstream river pollution, especially from many residential areas suffer from the downstream section of pollutants accumulate downstream section. Therefore, the use of water during the water is still on land must be used effectively, efficiently and sustainability (Soewarno, 1991).

Watersheds (*Daerah Aliran Sungai*) as a whole ecosystem consists of several interrelated components. Human as one of the main components in the watershed is very influential presence of watershed. Increased rapid population growth in a river basin causes the higher land requirement for various emanfaatan to their daily lives. People's activities in land use affect the pattern of land use. Limitations of land causes the increasing utilization of land that does not comply with land capability. Related to issues raised in the watershed, see the trend increasing watershed land degradation caused by the incompatibility of land use with land capability. Land degradation would indirectly reduce the carrying capacity of land.

A huge water demand is largely derived from irrigation water used to meet the needs of rice crop, while the irrigation water used for agriculture is very little dry land. Irrigation is an important component of agricultural activities mostly located in rural areas.

Limitations of water for agriculture not only occur in the dry season but also the rainy season could happen. Limitations of water cause a reduction in acreage, the type and amount of agricultural production. By utilizing the river through irrigation to irrigate their yards, especially paddy fields with rice-rice cropping pattern-pulses and vegetable commodities such as beans, cucumbers, peppers, spinach, kale and eggplant and fish pond. The watershed use patterns Baturusa - Cerucuk contained in the Bangka island and Belitung island divided into several water district as shown in the Table 3.18.

Table 3.18. Distribution area of water district.

Regencies/district	Water District	Area (sq. km)	
		Watershed	Subdistrict
Bangka			
Sungailiat	Sungailiat	-	-
Bakam	Baturusa upper course	624.127	145.49
Pemali	S.liat-upper course right branch	-	410.96
Merawang	Jeruk river – central	535.324	145.78
Puding Besar	Baturusa upper course	648.844	356.82
	Jeruk river – upper course	535.324	393.42
Mendo Barat	Menduk river	387.287	522.63
Belinyu	Effluent of stream flow	18.450	446.55
Riau Silip	Layang river	359.584	529.03
		3,108.937	**2,951.67**
Western Bangka			
Muntok	Effluent of stream flow	-	329.08
Simpang Teritip	Kelapa river	-	769.59
Kelapa	Mancong river	624.127	617.78
Tempilang	Mancong river	-	440.87
Jebus	Kampak river	357.642	663.29
		981.769	**2,820.61**
Central Bangka			
Koba	Nibung river	148.814	937.66
Pangkalan Baru	Kurau river	570.321	256.97
Sungai Selan	Sungai selan – central	527.55	663.76
Simpang Katis	Sungai selan – upper course	-	268.38
		1,246.685	**2,126.77**
Southern Bangka			
Payung	Bangka kota river – upper course		
	Bangka kota river – lower course	521.934	760.63
Simpang Rimba	Kepoh river,	-	576.11
Toboali	Gusung river, Nyireh river	454.804	1,072.62
		191.381	-
		299.243	-
Air Gegas	Kepoh river – upper course	454.804	948.41
Lepar Pongok	Lepar island	-	249.31
Tukak		-	-
Sadai		-	-
		1,925.166	**3,607.08**
Pangkalpinang			
Rangkui	Baturusa river–Rangkui river	648.844	7.87
Bukit Intan	Baturusa river	-	36.54
Pangkal Balam	Selindung river	310.150	35.56
Taman Sari	Baturusa river	-	1.33
Gerunggang	Rangkui river	15.140	37.10
		974.134	**118.408**
Belitung			
Membalong	Membalong river, Kurau river,	-	
	Peka river	102.966	909.55
Tanjung Pandan	Cerucuk river, Brang river	551.388	378.45
Badau	Cerucuk river-upper course, Buding river	183.289	413.99
Sijuk	Sengkali river, Buding river	482.615	458.20
Selat Nasik	Effluent in the Mendanau island	-	133.50
		1,320.258	**2,293.69**
Eastern Belitung			
Manggar	Manggar river	282.624	377
Gantung	Lingang river	697.275	937
Dendang	Balok river, Senusur river, Peso river, sambuko river	121.552	605.5
Kelapa Kampit	Buding river	482.615	587.41
		1,584.066	**2,506.91**

Source : Departement of Public Work, Directorate General of Water Resources, Regional of Sumatera VIII, 2007.

CHAPTER IV

Water Resources

CHAPTER IV

WATER RESOURCES

4.1. Rivers System and Their Flows

A river or a stream is formed whenever water moves downhill from one place to another. This means that most rivers begin high up in the mountains or hills. On their way down to the sea, they collect water from rain, and from other streams. There is another place where rivers rise up from springs. Where groundwater seeps up onto the surface, it may form a lake or pool or it may start running downhill right away, but one way or another, it is a river's beginning.

For the river is flowing, it flows deep beneath the bottom of the river (the substrate), and it flows underneath the ground on both sides of it. The underground area where the river flows is called the hyporheic zone. In the hyporheic zone, many forms of life can be found. Hiding down there between the rocks protects them from predators, yet the water still flows to them, bringing them nutrients.

Depending on how gravelly or rocky the ground is, a river's hyporheic zone has been found to extend far away from the part of the river, far into the river's floodplain. In fact, wells drilled into the earth for houses near rivers. The more gravelly the ground, the farther the hyporheic zone will extend. In reality, a stream, its underground hyporheic zone, and its aquifer beneath the hyporheic zone are all part of a single system.

Aquifers are sometimes called water tables, though a water table is actually just the top margin of an aquifer. There is always a vast field of water.

This is an aquifer, sometimes called groundwater. Some aquifers, cover large regions of the country. Water that has fallen as precipitation and soaks into the ground eventually reaches a level that it has a harder time soaking into. Since it can't flow straight down anymore, it moves sideways but still downhill. This means that huge sheets of fresh water are slowly moving underneath they are in effect underground streams.

4.2. Drain and Their Flows

Drains and their flows are specialized drainage systems which are designed to handle an excess of water as a result of flooding or heavy rainfall. They are frequently found in major cities, especially in flood prone areas. A number of systems are used for the collection and ultimate discharge of water from storm drains, and if there are storm drains in your area, it may be interesting for you to learn about how the water is processed before it is discharged.

When rainfall is heavy, the streets, parking lots, and other flat areas of a town can flood. In addition to the water falling directly on these surfaces, gutters also discharge large amounts of water into the street. The flooding can pose a hazard, which is why storm strains are installed. The storm drains are frequently located on either side of a street, at a low point in the roadway where water would naturally collect. Typically, a large grate covers the storm drain, which takes the form of a giant pipe.

The storm drains are known as storm water drains or a surface water system. Water flows down the pipes and meets up with other pipes, creating an ever larger central pipe. In many areas, the storm drain system is kept entirely separate from the sewer system. The outlet for the pipe is found by a lake, ocean, or other major body of water. In other cases, storm drains are connected with the sewer system, and the water from the drains is processed before it is disposed.

When water from the storm drains flows into a body of water, it can potentially distribute flooding to locations downstream, in the case of a river. It also poses a major pollution risk, because spills in the streets will be carried through the unfiltered storm drain system.

4.3. Water Quality of Streams

The water quality of stream discribe into; physical characteristics, chemical characteristics and biological characteristics.

4.3.1. Physical characteristics

4.3.1.1. Temperature

The water temperature of the Baturusa River at Bangka Islands, usually fluctuates through approximately 1°C to 2°C on a diurnal cycle. As expected, the water temperature increases during daylight hours and declines again during the night. Cloudy days and nights make for smaller daytime increases and smaller nighttime decreases. Clear days and nights with increased insolation and radiational cooling make for greater daytime increases and greater nighttime decreases.

The initial rapid rise in water temperature can be attributed to the sudden influx of this warmer water, due to the surge of upriver rainfall pushing the shoal area water downstream into lower course. The continued flow of water from upriver, began pushing the now cooler upstream water into the lower course area. This upriver water was basically the new shower form precipitation falling into the river and the drainage from the immediate watershed area adjacent to the river. This rain was from cumulonimbus clouds with great vertical extent. This rain was considerably cooler than the ambient river temperature. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.1.2. TDS (Total Disolved Solid)

Total Dissolved Solids (often abbreviated TDS) is a measure of the combined content of all inorganic and organic substances contained in a liquid in: molecular, ionized or micro-granular (colloidal sol)[1] suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a sieve the size of two micrometer. Total dissolved solids are normally discussed only for freshwater systems, as salinity comprises some of the ions constituting the definition of TDS. The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is not generally considered a primary pollutant (e.g. it is not deemed to be associated with health effects) it is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants.

Primary sources for TDS in receiving waters are agricultural and residential runoff, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants. The most common chemical

[1] A **sol** is a colloidal suspension of solid particles in a continuous liquid medium. Examples include blood, pigmented ink, and paint. Artificial sols may be prepared by dispersion or condensation. Dispersion techniques include grinding solids to colloidal dimensions by ball milling and Bredig's arc method. The stability of sols may.be maintained by using dispersing agents. Sols are commonly used in preparing sol-gels. The diameter of its particles are very small.It is quite stableand shows tyndall effect.

constituents are calcium, phosphates, nitrates, sodium, potassium and chloride, which are found in nutrient runoff, general stormwater runoff and runoff from snowy climates where road de-icing salts are applied. The chemicals may be cations, anions, molecules or agglomerations on the order of one thousand or fewer molecules, so long as a soluble micro-granule is formed. More exotic and harmful elements of TDS are pesticides arising from surface runoff. Certain naturally occurring total dissolved solids arise from the weathering and dissolution of rocks and soils. The United States has established a secondary water quality standard of 500 mg/l to provide for drinking water.

High TDS levels generally indicate hard water, which can cause scale build-up in pipes, valves, and filters, reducing performance and adding to system maintenance costs. These effects can be seen in aquariums, spas, swimming pools, and reverse osmosis water treatment systems. Typically, in these applications, total dissolved solids are tested frequently, and filtration membranes are checked in order to prevent adverse effects.

In the case of hydroponics and aquaculture, TDS is often monitored in order to create a water quality environment favorable for organism productivity. For freshwater oysters, trouts, and other high value seafood, highest productivity and economic returns are achieved by mimicking the TDS and pH levels of each species' native environment. For hydroponic uses, total dissolved solids is considered one of the best indices of nutrient availability for the aquatic plants being grown. Because the threshold of acceptable aesthetic criteria for human drinking water is 100 mg/l, there is no general concern for odor, taste, and color at a level much lower than is required for harm. A number of studies have been conducted and indicate various species reactions range from intolerance to outright toxicity due to elevated TDS. The numerical results must be interpreted cautiously, as true toxicity outcomes will relate to specific chemical constituents. Nevertheless, some numerical information is a useful guide to the nature of risks in exposing aquatic organisms or terrestrial animals to high TDS levels. Most aquatic ecosystems involving mixed fish fauna can tolerate TDS levels of 1000 mg/l.

Spawning fishes appear to be more sensitive to high TDS levels. For example, it was found that concentrations of 350 mg/l TDS reduced spawning of Striped bass (Morone saxatilis)[2], and that concentrations below 200 mg/l promoted even healthier spawning conditions. In the river, cutthroat trout were subject to higher mortality when exposed to thermal pollution stress. combined with high total dissolved solids concentrations.

For terrestrial animals, poultry typically possess a safe upper limit of TDS exposure of approximately 2900 mg/l, whereas dairy cattle are measured to have a safe upper limit of about 7100 mg/l. Research has shown that exposure to TDS is compounded in toxicity when other stressors are present, such as abnormal pH, high turbidity, or reduced dissolved oxygen with the latter stressor acting only in the case of animalia. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2. Chemical characteristics

4.3.2.1. pH

[2] The **striped bass** (*Morone saxatilis*, also called Atlantic striped bass, stripers, linesiders, rock, pimpfish,or rockfish) is the state fish of Maryland, Rhode Island, South Carolina, and the state saltwater (marine) fish of New York and New Hampshire. They are also found in the Minas Basin and Gaspereau River in Nova Scotia Canada.The striped bass is a typical member of the Moronidae family in shape, having a streamlined, silvery body marked with longitudinal dark stripes running from behind the gills to the base of the tail. Maximum size is 200 cm (6.6 ft) and maximum scientifically recorded weight 57 kg (125 US pounds). Striped bass are believed to live for up to 30 yearStriped bass are native to the Atlantic coastline of North America from the St. Lawrence River into the Gulf of Mexico to approximately Louisiana. They are anadromous fish that migrate between fresh and salt water. Spawning takes place in fresh water.

In chemistry, pH is a measure of the acidity or basicity of a solution. A low pH indicates a high concentration of hydronium ions, while a high pH indicates a low concentration. Crudely, this negative of the logarithm matches the number of places behind the decimal point, so for example 0.1 molar hydrochloric acid should be near pH 1 and 0.0001 molar HCl should be near pH 4 (the base 10 logarithms of 0.1 and 0.0001 being −1, and −4, respectively). Pure water is neutral, and can be considered either a very weak acid or a very weak base (center of the 0 to 14 pH scale), giving it a pH of 7 at 25°C (77°F), or 0.0000001 M H+. For an aqueous solution to have a higher pH, a base must be dissolved in it, which binds away many of these rare hydrogen ions. Hydrogen ions in water can be written simply as H+ or as hydronium (H_3O+) or higher species (e.g. H_9O_4+) to account for solvation, but all describe the same entity.

However, pH is not precisely p[H], but takes into account an activity factor. This represents the tendency of hydrogen ions to interact with other components of the solution, which affects among other things the electrical potential read using a pH meter. As a result, pH can be affected by the ionic strength of a solution for example, the pH of a 0.05 M potassium hydrogen phthalate solution can vary by as much as 0.5 pH units as a function of added potassium chloride, even though the added salt is neither acidic nor basic.

Unfortunately, hydrogen ion activity coefficients cannot be measured directly by any thermodynamically sound method, so they are based on theoretical calculations. Therefore the pH scale is defined in practice as traceable to a set of standard solutions whose pH is established by international agreement. Primary pH standard values are determined by the Harned cell, a hydrogen gas electrode, using the Bates-Guggenheim Convention[3].

Pure water is said to be neutral, with a pH close to 7.0 at 25 °C (77 °F). Solutions with a pH less than 7 at 25 °C (77 °F) are said to be acidic and solutions with a pH greater than 7 at 25 °C (77 °F) are said to be basic or alkaline. pH measurements are important in medicine, biology, chemistry, food science, environmental science, oceanography, civil engineering and many other applications. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.2. Disolved Oxigen (DO)

Dissolved oxygen (DO) is measured in standard solution units such as millilitres O_2 per liter (ml/L), millimoles O_2 per liter (mmol/L), milligrams O_2 per liter (mg/L) and moles O_2 per cubic meter (mol/m^3). For example, in freshwater under atmospheric pressure at 20°C, O_2 saturation is 9.1 mg/L.

Dissolved oxygen is probably the single most important water quality factor that pond managers need to understand. Oxygen dissolves in water at very low concentrations. Our atmosphere is 20% oxygen or 200,000 ppm but seldom will a pond have more than 10 ppm oxygen dissolved in its water. Dissolved oxygen concentrations below 3 ppm stress most warmwater species of fish and concentrations below 2 ppm will kill some species. Often fish that have been stressed by dissolved oxygen concentrations in the range of 2 or 3 ppm will become susceptible to disease.

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[3] This convention, which came to be called the Bates-Guggenheim (BG) convention, was intended for use at ionic strengths not in excess of 0.1. It formed the basis for the assignment of pH values to the NBS pH standards, also adopted by IUPAC and several industrialized nations. This is a "multistandard" scale with several fixed points. The British Standards Institute endorses a pH scale fixed by a single primary standard, with other reference points, designated "secondary", used for confirmation The NBS pH scale, however, is maintained through issuance of a series of standard reference materials. The name of its parent institution National Bureau of Standards (NBS), however, has been superseded by "National Institute of Standards and Technology" (NIST). All of the fixed points on the scale are regarded to be endowed with equal validity. These standards consist of stable aqueous buffer mixtures selected to span the useful range of pH.

Oxygen dissolves into water from two sources: the atmosphere and from plants in the water. The primary source of oxygen for a pond is from microscopic algae (phytoplankton) or submerged plants.. In the presence of sunlight, these produce oxygen through photosynthesis and release this oxygen into the pond water. At night and on very cloudy days, algae and submerged plants remove oxygen from the water for respiration. During daylight hours plants normally produce more oxygen than they consume, thus providing oxygen for the fish and other organisms in the pond.

Oxygen depletions are the most common cause of fish kills in ponds. Most oxygen deletions occur in the summer months because; 1) warm water holds less dissolved oxygen than cool or cold water, and 2) because the pond's oxygen demand is greater in warm water than in cold water. Fish kills from oxygen depletions can range from "partial" to "total". In a partial kill the dissolved oxygen level gets low enough to suffocate sensitive species and large fish, but many small fish and hardy species survive. Most oxygen depletions cause partial fish kills; total fish kills are relatively rare in recreational ponds except for those with extremely high fish populations (>1,000 pounds/acre). Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.3. Biochemical Oxigen Demand (BOD)

Biochemical oxygen demand is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter. Natural sources of organic matter include plant decay and leaf fall. However, plant growth and decay may be unnaturally accelerated when nutrients and sunlight are overly abundant due to human influence. Urban runoff carries pet wastes from streets and sidewalks; nutrients from lawn fertilizers; leaves, grass clippings, and paper from residential areas, which increase oxygen demand. Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen they need to live. Organisms that are more tolerant of lower dissolved oxygen levels may replace a diversity of natural water systems contain bacteria, which need oxygen (aerobic) to survive. Most of them feed on dead algae and other dead organisms and are part of the decomposition cycle. Algae and other producers in the water take up inorganic nutrients and use them in the process of building up their organic tissues.

Consumers like fish and other aquatic animals eat some of the producers, and the nutrients move up the food chain. When these organisms die, bacteria decompose the organic compounds and release into the water inorganic nutrients such as nitrate, phosphate, calcium, and others. Some of these nutrients end up down stream or in sediments, but most of them recycle again and again. Most of the bacteria in the aquatic water column are aerobic. That means that they use oxygen to perform their metabolic activities of decomposition. Remember that we learned in other related exercises that under normal conditions, dissolved oxygen exists in very low concentrations. Natural levels of oxygen in aquatic systems are always somewhat depleted by normal levels of aerobic bacterial activity. In most cases, if dissolved oxygen concentrations drop below 5 parts per million (ppm), fish will be unable to live for very long. All clean water species such as trout or salmon will die well above this level and even low oxygen fish such as catfish and carp will be at risk below 5 ppm.

When abnormally high levels of aerobic bacterial activity takes place, however, the level of dissolved oxygen can drop dramatically. Generally, this occurs when there is some sort of abnormal "pollution" introduced into the system. This can occur in the form of organic pollution for sources such as domestic sewage, septic tank leakage, and fertilizer runoff, or could be in the form of inorganics from domestic or industrial sources. Natural sources of organic compounds can also come into aquatic systems by means of floods, landslides, and erosion. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.4. Chemical Oxigen Demand (COD)

Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. COD measurements are commonly made on samples of waste waters or of natural waters contaminated by domestic or industrial wastes. Chemical oxygen demand is measured as a standardized laboratory assay in which a closed water sample is incubated with a strong chemical oxidant under specific conditions of temperature and for a particular period of time. A commonly used oxidant in COD assays is potassium dichromate ($K_2Cr_2O_7$) which is used in combination with boiling sulfuric acid (H_2SO_4). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD assay.

Chemical oxygen demand is related to biochemical oxygen demand (BOD), another standard test for assaying the oxygen-demanding strength of waste waters. However, biochemical oxygen demand only measures the amount of oxygen consumed by microbial oxidation and is most relevant to waters rich in organic matter. It is important to understand that COD and BOD do not necessarily measure the same types of oxygen consumption. For example, COD does not measure the oxygen-consuming potential associated with certain dissolved organic compounds such as acetate. However, acetate can be metabolized by microorganisms and would therefore be detected in an assay of BOD. In contrast, the oxygen-consuming potential of cellulose is not measured during a short-term BOD assay, but it is measured during a COD test. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.5. Total Phosphat

Phosphorus (P) is an essential nutrient for all life forms. Phosphorus plays a role in deoxyribonucleic acid (DNA), ribonucleic acid (RNA), adenosine diphosphate (ADP), and adenosine triphosphate (ATP). Phosphorus is required for these necessary components of life to occur.

Phosphorus is the eleventh-most abundant mineral in the earth's crust and does not exist in a gaseous state. Natural inorganic phosphorus deposits occur primarily as phosphate in the mineral apatite. Apatite is defined as a natural, variously colored calcium fluoride phosphate ($Ca_5F(PO_4)_3$) with chlorine, hydroxyl, and carbonate sometimes replacing the fluoride. Apatite is found in igneous and metamorphic rocks, and sedimentary rocks. When released into the environment, phosphate will spread as orthophosphate according to the pH of the surrounding soil.

Phosphate is usually not readily available for uptake in soils. Phosphate is only freely soluble in acid solutions and under reducing conditions. In the soil it is rapidly immobilized as calcium or iron phosphates. Most of the phosphorus in soils is adsorbed to soil particles or incorporated into organic matter (Smith, 1990; Craig et al., 1988; Holtan et al., 1988).

Phosphorus in freshwater exists in either a particulate phase or a dissolved phase. Particulate matter includes living and dead plankton, precipitates of phosphorus, phosphorus adsorbed to particulates, and amorphous phosphorus. The dissolved phase includes inorganic phosphorus (generally in the soluble orthophosphate form), organic phosphorus excreted by organisms, and macromolecular colloidal phosphorus.

The organic and inorganic particulate and soluble forms of phosphorus undergo continuous transformations. The dissolved phosphorus (usually as orthophosphate) is assimilated by phytoplankton and altered to organic phosphorus. The phytoplankton are then ingested by detritivores or zooplankton. Over half of the organic phosphorus taken up by zooplankton is excreted as inorganic P. Continuing the cycle, the inorganic P is rapidly assimilated by phytoplankton (Smith, 1990; Holtan et al., 1988).

Lakes and reservoir sediments serve as phosphorus sinks. Phosphorus-containing particles settle to the substrate and are rapidly covered by sediment. Continuous accumulation of sediment will leave some phosphorus too deep within the substrate to be reintroduced to the water column. Thus, some phosphorus is removed permanently from biocirculation (Smith, 1990; Holtan et al., 1988).

A portion of the phosphorus in the substrate may be reintroduced to the water column. Phosphorus stored in the uppermost layers of the bottom sediments of lakes and reservoirs is subject to bioturbation by benthic invertebrates and chemical transformations by water chemistry changes. For example, the reducing conditions of a hypolimnion often experienced during the summer months may stimulate the release of phosphorus from the benthos. Recycling of phosphorus often stimulates blooms of phytoplankton. Because of this phenomenon, a reduction in phosphorus loading may not be effective in reducing algal blooms for a number of years (Maki et al., 1983). Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.6. Nitrate (NO_3)

Nitrate (NO_3-) and nitrite (NO_2-) are naturally occurring inorganic ions that are part of the nitrogen cycle. Microbial action in soil or water decomposes wastes containing organic nitrogen into ammonia, which is then oxidized to nitrite and nitrate. Because nitrite is easily oxidized to nitrate, nitrate is the compound predominantly found in groundwater and surface waters. Contamination with nitrogen-containing fertilizers (e.g. potassium nitrate and ammonium nitrate), or animal or human organic wastes, can raise the concentration of nitrate in water. Nitrate-containing compounds in the soil are generally soluble and readily migrate with groundwater.

Shallow, rural domestic wells are those most likely to be contaminated with nitrates, especially in areas where nitrogen-based fertilizers are in widespread use. In agricultural areas, nitrogen-based fertilizers are a major source of contamination for shallow groundwater aquifers that provide drinking water. A recent United States Geological Survey study showed that more than 8,200 wells nationwide were contaminated with nitrate levels above the U.S. Environmental Protection Agency (EPA) drinking water standard of 10 parts per million (ppm). EPA has estimated that approximately 1.2% of community water wells and 2.4% of private wells exceed the nitrate standard.

Other sources of nitrate contamination are organic animal wastes and contamination from septic sewer systems, especially in wells less than 100 feet deep. During spring melt or drought conditions, both domestic wells and public water systems using surface water can show increased nitrate levels. Drinking water contaminated by boiler fluid additives may also contain increased levels of nitrites. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.7. Iron (Fe)

Iron forms compounds mainly in the +2 and +3 oxidation states. Traditionally, iron(II) compounds are called ferrous, and iron(III) compounds ferric. Iron also occurs in higher oxidation states, an example being the purple potassium ferrate (K_2FeO_4) which contains iron in its +6 oxidation state. Iron(IV) is a common intermediate in many in biochemical oxidation reactions. Numerous organometallic compounds contain formal oxidation states of +1, 0, −1, or even −2. The oxidation states and other bonding properties are often assessed using the technique of Mössbauer spectroscopy. There are also many mixed valence compounds that contain both iron(II) and iron(III) centers, such as magnetite and Prussian blue ($Fe_4(Fe[CN]_6)_3$). The latter is used as the traditional "blue" in blue prints. Hydrated iron(III) chloride, also known as ferric chloride.

The iron compounds produced on the largest scale in industry are iron(II) sulfate ($FeSO_4 \cdot 7H_2O$) and iron(III) chloride ($FeCl_3$). The former is one of the most readily available sources of iron(II), but is less stable to aerial oxidation than Mohr's salt ($(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$). Iron(II) compounds tend to be oxidized to iron(III) compounds in the air. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.8. Lead/Timbal (Pb)

Lead is a main-group element with symbol Pb (Latin: plumbum). Lead is a soft, malleable poor metal. It is also counted as one of the heavy metals. Metallic lead has a bluish-white color after being freshly cut, but it soon tarnishes to a dull grayish color when exposed to air. Lead has a shiny chrome-silver luster when it is melted into a liquid.

Lead is a poisonous metal that can damage nervous connections (especially in young children) and cause blood and brain disorders. Lead poisoning typically results from ingestion of food or water contaminated with lead; but may also occur after accidental ingestion of contaminated soil, dust, or lead based paint. Long-term exposure to lead or its salts (especially soluble salts or the strong oxidant PbO_2) can cause nephropathy[4], and colic-like abdominal pains. The effects of lead are the same whether it enters the body through breathing or swallowing. Lead can affect almost every organ and system in the body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys

[4] refers to damage to or disease of the kidney. An older term for this is **nephrosis**. Causes of nephropathy include administration of analgesics, xanthine oxidase deficiency, and long-term exposure to lead or its salts. Chronic conditions that can produce nephropathy include systemic lupus erythematosus, diabetes mellitus and high blood pressure (hypertension), which lead to diabetic nephropathy and hypertensive nephropathy, respectively. One cause of nephropathy is the long term usage of analgesics. The pain medicines which can cause kidney problems include aspirin, acetaminophen, and nonsteroidal anti-inflammatory drugs, or NSAIDs. This form of nephropathy is "chronic analgesic nephritis," a chronic inflammatory change characterized by loss and atrophy of tubules and interstitial fibrosis and inflammation (BRS Pathology, 2nd edition). Specifically, long term use of the analgesic phenacetin has been linked to renal papillary necrosis (necrotizing papillitis).

in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage. Chronic, high-level exposure have shown to reduce fertility in males The antidote/treatment for lead poisoning consists of dimercaprol[5] and succimer[6].

The concern about lead's role in cognitive deficits in children has brought about widespread reduction in its use (lead exposure has been linked to learning disabilities). Most cases of adult elevated blood lead levels are workplace-related. High blood levels are associated with delayed puberty in girls. Lead has been shown many times to permanently reduce the cognitive capacity of children at extremely low levels of exposure. There appears to be no detectable lower limit below which lead has no effect on cognition.

During the 20th century, the use of lead in paint pigments was sharply reduced because of the danger of lead poisoning, especially to children. By the mid-1980s, a significant shift in lead end-use patterns had taken place.

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[5] Dimercaprol a chelating agent used in the treatment of heavy metal poisoning. The drug forms a relatively stable compound with arsenic, mercury, gold and certain other metals,. thus protecting the vital enzyme systems of the cells against the effects of the metals. It is sometimes diluted with water and used to wash the stomach, some of the solution being permitted to remain in the stomach. At the dose levels required for effect in ruminants at the level of poison dose experienced in agriculture, dimercaprol is itself poisonous. The drug has a very disagreeable skunklike odor and should be handled carefully to avoid spilling. Called also British antilewisite, BAL, dimercaptopropanol. Formerly caled **British antilewisite (BAL).** indications it is prescribed in the treatment of Wilson's disease and in the treatment of acute arsenic, mercury, or gold poisoning, as from an overdosage with mercurial diuretics, arsenics, or gold salts.

[6] Succimer (Chemet), a drug used to remove excess lead from the body. A water-soluble chelator administered per os for heavy metal poisoning–eg, lead poisoning in children > 2.17 µmol/L–US: 45 µg/dl or adults with lead poisoning due to gunshot wounds.

Much of this shift was a result of the U.S. lead consumer's compliance with environmental regulations that significantly reduced or eliminated the use of lead in non-battery products, including gasoline, paints, solders, and water systems. Lead use is being further curtailed by the European Union's RoHS[7] directive. Lead may still be found in harmful quantities in stoneware, vinyl (such as that used for tubing and the insulation of electrical cords), and brass manufactured in China.

Lead salts used in pottery glazes have on occasion caused poisoning, when acidic drinks, such as fruit juices, have leached lead ions out of the glaze. It has been suggested that what was known as "Devon colic" arose from the use of lead-lined presses to extract apple juice in the manufacture of cider. Lead is considered to be particularly harmful for women's ability to reproduce.

Lead as a soil contaminant is a wide spread issue, since lead is present in natural deposits and may also enter soil through (leaded) gasoline leaks from underground storage tanks or through a wastestream of lead paint or lead grindings from certain industrial operations.

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[7] **Restriction of Hazardous Substances Directive** or **RoHS**) was adopted in February 2003 by the European Union. The RoHS directive took effect on 1 July 2006, and is required to be enforced and become law in each member state. This directive restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment. It is closely linked with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC which sets collection, recycling and recovery targets for electrical goods and is part of a legislative initiative to solve the problem of huge amounts of toxic e-waste. Each European Union member state will adopt its own enforcement and implementation policies using the directive as a guide. **RoHS** is often referred to as the lead-free directive, but it restricts the use of the following six substances:

1. Lead (Pb)
2. Mercury (Hg)
3. Cadmium (Cd)
4. Hexavalent chromium (Cr^{6+})
5. Polybrominated biphenyls (PBB)
6. Polybrominated diphenyl ether (PBDE)

Lead can also be found listed as a criteria pollutant in the United States Clean Air Act section 108[8]. Lead that is emitted into the atmosphere can be inhaled, or it can be ingested after it settles out of the air. It is rapidly absorbed into the bloodstream and is believed to have adverse effects on the central nervous system, the cardiovascular system, kidneys, and the immune system.

In the human body, lead inhibits porphobilinogen synthase and ferrochelatase, preventing both porphobilinogen formation and the incorporation of iron into protoporphyrin IX, the final step in heme synthesis. This causes ineffective heme synthesis and subsequent microcytic anemia. At lower levels, it acts as a calcium analog, interfering with ion channels during nerve conduction. This is one of the mechanisms by which it interferes with cognition. Acute lead poisoning is treated using disodium calcium edetate: the calcium chelate of the disodium salt of ethylene-diamine-tetracetic acid (EDTA). This chelating agent has a greater affinity for lead than for calcium and so the lead chelate is formed by exchange. This is then excreted in the urine leaving behind harmless calcium. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.9. Zinc (Zn)

Zinc is an essential mineral of "exceptional biologic and public health importance". Zinc deficiency affects about two billion people in the developing

[8] **THE CLEAN AIR ACT** [As Amended Through P.L. 108–201, February 24, 2004], SEC. 108 AIR QUALITY CRITERIA AND CONTROL TECHNIQUES. For the purpose of establishing national primary and secondary ambient air quality tandards, the Administrator shall within 30 days after the date of enactment of the Clean Air Amendments of 1970 publish, and shall from time to time thereafter revise, a list which includes each air pollutant—

A. emissions of which, in his judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare;
B. the presence of which in the ambient air results from numerous or diverse mobile or stationary sources; and
C. for which air quality criteria had not been issued before the date of enactment of the Clean Air Amendments of 1970, but for which he plans to issue air quality criteria under this section.

world and is associated with many diseases. In children it causes growth retardation, delayed sexual maturation, infection susceptibility, and diarrhea, contributing to the death of about 800,000 children worldwide per year. Enzymes with a zinc atom in the reactive center are widespread in biochemistry, such as alcohol dehydrogenase in humans. Consumption of excess zinc can cause ataxia, lethargy and copper deficiency.

Levels of zinc in rivers flowing through industrial or mining areas can be as high as 20 ppm. Effective sewage treatment greatly reduces this; treatment along the Rhine, for example, has decreased zinc levels to 50 ppb. Concentrations of zinc as low as 2 ppm adversely affects the amount of oxygen that fish can carry in their blood.

Soils contaminated with zinc through the mining of zinc-containing ores, refining, or where zinc-containing sludge is used as fertilizer, can contain several grams of zinc per kilogram of dry soil. Levels of zinc in excess of 500 ppm in soil interfere with the ability of plants to absorb other essential metals, such as iron and manganese. Zinc levels of 2000 ppm to 180,000 ppm (18%) have been recorded in some soil samples.

Although zinc is an essential requirement for good health, excess zinc can be harmful. Excessive absorption of zinc suppresses copper and iron absorption. The free zinc ion in solution is highly toxic to plants, invertebrates, and even vertebrate fish. The Free Ion Activity Model is well-established in the literature, and shows that just micromolar amounts of the free ion kills some organisms. A recent example showed 6 micromolar killing 93% of all Daphnia in water.

The free zinc ion is a powerful Lewis acid up to the point of being corrosive. Stomach acid contains hydrochloric acid, in which metallic zinc dissolves readily to give corrosive zinc chloride. Swallowing a post-1982 American one cent piece (97.5% zinc) can cause damage to the stomach lining due to the high solubility of the zinc ion in the acidic stomach. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.10. Sulfide (S^{2-+})

Na_2S, and K_2S in the presence of extra hydroxide. The ion S_2- is exceptionally basic with a pKa>14. It does not exist in appreciable concentrations even in highly alkaline water, being undetectable at pH<~15 (8 M NaOH). Aqueous solutions of transition metals cations react with sulfide sources (H_2S, NaHS, Na_2S) to precipitate solid sulfides. Such inorganic sulfides typically have very low solubility in water, and many are related to minerals with the same composition. One famous example is the bright yellow species CdS or "cadmium yellow". The black tarnish formed on sterling silver is Ag_2S. Such species are sometimes referred to as salts. In fact, the bonding in transition metal sulfides is highly covalent, which gives rise to their semiconductor properties, which in turn is related to the deep colors.

Instead, sulfide combines with protons to form $HS-$, which is variously called hydrogen sulfide ion, hydrosulfide ion, sulfhydryl ion, or bisulfide ion. At still lower pH's (<7), $HS-$ converts to H_2S, hydrogen sulfide. Sulfides are moderately strong reducing agents. They react with oxygen in the air in elevated temperatures to form higher-valence sulfur salts, such as sulfates and sulfur dioxide. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.11. Phenol

It is slightly acidic: the phenol molecule has weak tendencies to lose the H+ ion from the hydroxyl group, resulting in the highly water-soluble phenolate anion $C_6H_5O^-$, called phenoxide anion. Compared to aliphatic alcohols, phenol shows much higher acidity (about 1 million times more acidic). It reacts completely with aqueous NaOH to lose H+, whereas most alcohols react only partially. Phenols are less acidic than carboxylic acids.

One explanation for the increased acidity over alcohols is resonance stabilization of the phenoxide anion by the aromatic ring. In this way, the negative charge on oxygen is shared by the ortho and para carbon atoms.In another explanation, increased acidity is the result of orbital overlap between the oxygen's lone pairs and the aromatic system in a third, the dominant effect is the induction from the sp2 hybridised carbons; the comparatively more powerful inductive withdrawal of electron density that is provided by the sp2 system compared to an sp3 system allows for great stabilization of the oxyanion.

Phenol and its vapors are corrosive to the eyes, the skin, and the respiratory tract. Repeated or prolonged skin contact with phenol may cause dermatitis, or even second and third-degree burns due to phenol's caustic and defatting properties. Inhalation of phenol vapor may cause lung edema. The substance may cause harmful effects on the central nervous system and heart, resulting in dysrhythmia, seizures, and coma. The kidneys may be affected as well. Exposure may result in death and the effects may be delayed. Long-term or repeated exposure of the substance may have harmful effects on the liver and kidneys." There is no evidence to believe that phenol causes cancer in humans. Besides its hydrophobic effects, another mechanism for the toxicity of phenol may be the formation of phenoxyl radicals.

Chemical burns from skin exposures can be decontaminated by washing with polyethylene glycol, isopropyl alcohol, or perhaps even copious amounts of water. Removal of contaminated clothing is required, as well as immediate hospital treatment for large splashes. This is particularly important if the phenol is mixed with chloroform (a commonly-used mixture in molecular biology for DNA & RNA purification from proteins). Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.12. Oil and fat

Fats oils and grease cause major problems to the sewerage, drainage and environment system. When they are discharged down kitchen sinks or foul drains they cause sewer and surface water blockages, when they are discharged down rainwater pipes and gullies they cause pollution in local watercourses. Fat, oil and grease in liquid form may not appear to be harmful, but as it cools it congeals and hardens. It sticks to the inner lining of drainage pipes and restricts the wastewater flow and causes the drain to block.

Using detergents or bleach may appear to help but this is only temporary as the mixture soon reverts back to thick or solid fat. The number of blockages and pollution incidents relating to fats, oils and greases are also increasing. also risk blocking their own drainage system, which will result in loss of income due to cleanup costs. In fact, every establishment disposing of fat, oil and grease into sinks and drains is at risk of experiencing damaging and costly drainage problems. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.2.13. Copper (Cu)

Copper(II) ions (Cu_2+) are soluble in water, where they function at low concentration as bacteriostatic substances, fungicides, and wood preservatives. In sufficient amounts, copper salts can be poisonous to higher organisms as well. However, despite universal toxicity at high concentrations, the Cu_2+ ion at lower concentrations is an essential trace nutrient to all higher plant and animal life. In animals, including humans, it is found widely in tissues, with concentration in liver, muscle, and bone. It functions as a co-factor in various enzymes and in copper-based pigments.

Copper is essential in all plants and animals. The human body normally contains copper at a level of about 1.4 to 2.1 mg for each kg of body weight. Copper is distributed widely in the body and occurs in liver, muscle and bone. Copper is transported in the bloodstream on a plasma protein called ceruloplasmin. When copper is first absorbed in the gut it is transported to the liver bound to albumin. Copper metabolism and excretion is controlled delivery of copper to the liver by ceruloplasmin, where it is excreted in bile.

It is believed that zinc and copper compete for absorption in the digestive tract so that a diet that is excessive in one of these minerals may result in a deficiency in the other. The RDA[9] for copper in normal healthy adults is 0.9 mg/day (Detail information presented in Appendix 4). On the other word, professional research on the subject recommends 3.0 mg/day. Because of its role in facilitating iron uptake, copper deficiency can often produce anemia-like

[9] **Reference Daily Intake (or Recommended Daily Intake) (RDI)**, RDIs are based on the older **Recommended Dietary Allowances (RDA)** from 1968 is the daily dietary intake level of a nutrient which was considered (at the time they were defined) to be sufficient to meet the requirements of nearly all (97–98%) healthy individuals in each life-stage and sex group. The RDI is used to determine the Daily Value which is printed on food labels in the U.S., Canada, and Australia.. Newer RDA's have since been introduced in the Dietary Reference Intake system, but the RDIs are still used for nutrition labeling.

symptoms. Conversely, an accumulation of copper in body tissues are believed to cause the symptoms of Wilson's disease in humans. Chronic copper depletion leads to abnormalities in metabolism of fats, high triglycerides, non-alcoholic steatohepatitis (NASH), fatty liver disease and poor melanin and dopamine synthesis causing depression and sunburn.

Toxicity can occur from eating acidic food that has been cooked with copper cookware. Cirrhosis of the liver in children (Indian Childhood Cirrhosis) has been linked to boiling milk in copper cookware. The Merck Manual states that recent studies suggest that a genetic defect is associated with this cirrhosis. Since copper is actively excreted by the normal body, chronic copper toxicosis in humans without a genetic defect in copper handling has not been demonstrated. However, large amounts (gram quantities) of copper salts taken in suicide attempts have produced acute copper toxicity in normal humans. Equivalent amounts of copper salts (30 mg/kg) are toxic in animals. Data recorded is presented in Table 4.1. and Table 4.2.

4.3.3. Biological characteristrics

Coliform is the name of a test adopted in 1914 by the Public Health Service for the Enterobacteriaceae family. It is the commonly-used bacterial indicator of sanitary quality of foods and water. They are defined as rod-shaped Gram-negative non-spore forming organisms. Some enteron forms can ferment lactose with the production of acid and gas when incubated at 35°C - 37°C. Coliforms are abundant in the feces of warm-blooded animals, but can also be found in the aquatic environment, in soil and on vegetation. In most instances, coliforms themselves are the cause of many nosocomial illnesses, they are easy to culture and their presence is used to indicate that other pathogenic organisms of fecal origin may be present. Fecal pathogens include bacteria, viruses, protozoa, and many multicellular parasites.

General type include:

1. *Citrobacter*; is a genus of Gram-negative coliform bacteria in the Enterobacteriaceae family. The species C. amalonaticus, C. koseri, and C. freundii use solely citrate as a carbon source. Citrobacter species are differentiated by their ability to convert tryptophan to indole, ferment lactose, and utilize malonate. Citrobacter shows the ability to accumulate uranium by building phosphate complexes. These bacteria can be found almost everywhere in soil, water, wastewater, etc. It can also be found in the human intestine. They are rarely the source of illnesses, except for infections of the urinary tract and infant meningitis and sepsis. Data recorded is presented in Table 4.1. and Table 4.2.
2. *Enterobacter*; is a genus of common Gram-negative, facultatively-anaerobic, rod-shaped bacteria of the family Enterobacteriaceae. Several strains of the these bacteria are pathogenic and cause opportunistic infections in immunocompromised (usually hospitalized) hosts and in those who are on mechanical ventilation. The urinary and respiratory tract are the most common sites of infection. It is also a fecal coliform, along with *Escherichia*.
3. *Escherichia*, or commonly abbreviated as E. coli, is one of the main species of gram-negative bacteria. In general, bacteria that was discovered by Theodor Escherich can be found in the human colon. Most E. Coli are harmless, but some, such as E. Coli type O157:H7, can cause serious food poisoning in

humans. E. Coli that are harmless to humans benefit by producing vitamin K_2, or by preventing other bacteri in the gut. E. coli is widely used in genetic engineering technology. Usually used as vectors to insert specific genes are desired to be developed. Escherichia coli (E. coli), a rod-shaped member of the coliform group, can be distinguished from most other coliforms by its ability to ferment lactose at 44°C in the fecal coliform test, and by its growth and color reaction on certain types of culture media.

When cultured on an EMB plate[10], a positive result for E. coli is metallic green colonies on a dark purple media. Unlike the general coliform group, E. coli are almost exclusively of fecal origin and their presence is thus an effective confirmation of fecal contamination. Typically, E. coli are about 11% of the coliforms in human feces. Data recorded is presented in Table 4.1. and Table 4.2.

4. *Klebsiella*; is a genus of non-motile, Gram-negative, oxidase-negative, rod shaped bacteria with a prominent polysaccharide-based capsule. It is named after the German microbiologist Edwin Klebs (1834–1913). Frequent human pathogens, *Klebsiella* organisms can lead to a wide range of disease states, notably pneumonia, urinary tract infections, septicemia, ankylosing spondylitis, and soft tissue infections. *Klebsiella* species are ubiquitous in nature.

[10] **Eosin Methylene Blue (EMB)** is a selective stain for Gram-negative bacteria. It is a blend of two stains, eosin and methylene blue in the ratio of 6:1. A common application of this stain is in the preparation of **EMB agar**, a differential microbiological medium, which inhibits the growth of Gram-positive bacteria and provides a color indicator distinguishing between organisms that ferment lactose (e.g., E. coli) and those that do not (e.g., Salmonella, Shigella). Organisms that ferment lactose display "nucleated colonies" - colonies with dark centers.

5. *Serratia*; is a genus of Gram-negative, facultatively anaerobic, rod-shaped bacteria of the Enterobacteriaceae family. The most common species in the genus, *S. marcescens*, is normally the only pathogen and usually causes nosocomial infections. However, rare strains of *S. plymuthica*, *S. liquefaciens*, *S. rubidaea*, and *S. odoriferae* have caused diseases through infection. Members of this genus produce characteristic red pigment, prodigiosin, and can be distinguished from other members of the family Enterobacteriaceae by its unique production of three enzymes: DNase [11], lipase[12], and gelatinase[13].

[11] **DNase (deoxyribonuclease)** is any enzyme that catalyzes the hydrolytic cleavage of phosphodiester linkages in the DNA backbone. Thus, deoxyribonucleases are one type of nuclease. A wide variety of deoxyribonucleases are known, which differ in their substrate specificities, chemical mechanisms, and biological functions.

[12] **Lipase** is a water-soluble enzyme that catalyzes the hydrolysis of ester chemical bonds in water-insoluble lipid substrates. Lipases are a subclass of the esterases. Lipases perform essential roles in the digestion, transport and processing of dietary lipids (e.g. triglycerides, fats, oils) in most, if not all, living organisms. Genes encoding lipases are even present in certain viruses.

[13] **Gelatinase** is a proteolytic enzyme that allows a living organism to hydrolyse gelatin into its sub-compounds (polypeptides, peptides, and amino acids) that can cross the cell membrane and be used by the organism. It is not a pepsin.

Table 4.1.
Results of Water Quality in Baturusa Cerucuk River Zone (Rainy/wet Season)

No	Parameters	Unit	Standard of Quality				Mentok			Jering			Gusung			Jeruk			Lemggang		
			I	II	III	IV	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	A. Physical																				
1	Temperature	°C	Dev 3	Dev 3	Dev 3	Dev 3	29.8	29.7	33.5	32.6	30.8	30.8	33.6	31.7	35.6	30.1	28.9	29.5	31.1	30.7	30.7
2	TDS	mg/l	1000	1000	1000	1000	170	174	229	386	369	482	115	205	280	346	167	280	98	94	81
	B. Chemical																				
3	pH	mg/l	6 - 7	5.6 - 6	5.6 - 6	4.5-5.5	6.2	7.3	7.9	6.9	7.2	7.5	7.9	7.8	8.7	7.2	6.9	7.4	7.3	7.3	7.5
4	DO	mg/l	6	4	3	0	2.8	2.4	2.62	1.89	0.98	1.33	10.09	1.81	9.4	1.63	2.05	1.95	10	11.07	5.93
5	BOD	mg/l	2	3	6	12	4.9	4.7	6.4	4.9	6.5	6.01	6.71	7.15	6.1	5.55	5.3	5.6	6.91	6.8	4.5
6	COD	mg/l	10	25	50	100	17.02	15.11	15.08	9.07	8.71	8.22	20.7	9.08	15.21	11.41	11.28	13.08	8.03	7.93	6.03
7	Total Phosphat	mg/l	0.2	0.2	1	0.2	0.21	0.15	0.15	0.08	0.05	0.08	0.18	0.05	0.13	0.08	0.11	0.08	0.13	0.08	0.05
8	Nitrate	mg/l	10	10	20	20	0.51	0.48	0.33	0.3	0.62	0.07	0.41	0.12	0.09	0.28	0.27	0.18	0.06	0.05	0.03
9	Amoniak	mg/l	0.5	-	-	-	1.86	1.03	1.6	1.04	0.65	0.5	1.08	1.91	1.51	1.73	1.45	1.32	0.54	0.58	0.44
10	Detergent	mg/l	200	200	200	200	5	3	0	2	3	0	5	2	2	2	2	0	2	3	2
11	Iron (Fe)	mg/l	0.3	0.3	-	-	1.41	1.3	1.28	0.72	1.12	1.12	1.04	1.06	0.09	0.84	1.08	1.03	0.05	0.03	0.03
12	Lead/Timbal (Pb)	mg/l	0.03	0.03	0.03	1	0.03	0	0.001	0.003	0.01	0.003	0.001	0	0.002	0.03	0	0.007	0	0	0
13	Zinc (Zn)	mg/l	0.05	0.05	0.05	2	0.07	0.006	0.11	1.42	0.91	0.04	1.86	1.02	0.98	1.16	0.21	0.91	0.08	0.03	0.02
14	Sulfide (H2S)	mg/l	0.002	0.002	0.002	-	1.32	0.91	0.8	1.09	1.07	1.24	2.3	1.82	1.13	1.27	1.04	0.05	0.72	0.61	0.35
15	Phenol	mg/l	1	1	1	-	0.08	0.06	0.06	0.02	0.06	0.03	0.15	0.03	0.02	0.03	0	3	0.03	0.04	0.02
16	Oil & Fat	mg/l	1000	1000	1000	-	6	2	3	5	11	7	6	4	3	2	0	0	2	2	0
17	Copper (Cu)	mg/l	0.02	0.02	0.02	0.02	0	0	0	0.005	0	0	0	0	0	0	0	0	0	0	0
	C. Biological																				
18	Coliform	mg/l	100	1000	2000	2000	33	23	26	11	5	5	46	23	17	31	27	27	7	5	5
19	Colifecal	mg/l	1000	5000	10000	10000	14	17	11	5	4	4	17	14	14	17	11	8	2	2	0

Table 4.2.
Results of Water Quality in Baturusa Cerucuk River Zone (Dry Season)

No	Parameters	Unit	Standard of Quality				Mentok			Jering			Gusung			Jeruk			Lemggang		
			I	II	III	IV	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	A. Physical																				
1.	Temperature	°C	Dev 3	Dev 3	Dev 3	Dev 3	30.1	29.9	33.6	32.8	30.9	31.2	33.9	31.9	35.7	30.3	29.1	29.6	31.3	30.8	30.9
2.	TDS	mg/l	1000	1000	1000	1000	167	168	218	373	357	476	111	196	272	341	158	273	93	89	78
	B. Chemical																				
3.	pH	mg/l	6 - 7	5.6 - 6	5.6 - 6	4.5-5.5	6.3	7.3	8.0	6.8	7.0	7.4	8.0	7.9	8.9	7.3	6.9	7.4	7.2	7.2	7.4
4.	DO	mg/l	6	4	3	0	3.0	2.7	2.69	1.93	1.12	1.53	11.07	1.81	9.9	1.69	2.15	2.05	11.20	11.97	6.85
5.	BOD	mg/l	2	3	6	12	5.9	5.5	6.9	5.9	7.2	6.9	7.52	8.11	7.01	6.15	6.13	6.06	7.81	7.04	5.15
6.	COD	mg/l	10	25	50	100	17.13	15.21	16.01	9.27	8.79	8.30	21.4	10.01	15.29	11.50	11.34	13.21	8.11	8.33	6.71
7.	Total Phosphat	mg/l	0.2	0.2	1	0.2	0.31	0.21	0.21	0.09	0.07	0.08	0.21	0.09	0.17	0.10	0.11	0.10	0.17	0.10	0.08
8.	Nitrate	mg/l	10	10	20	20	0.59	0.52	0.39	0.35	0.69	0.13	0.48	0.20	0.13	0.32	0.30	0.21	0.11	0.10	0.08
9.	Amoniak	mg/l	0.5	-	-	-	1.90	1.09	1.11	1.08	0.70	0.59	1.12	1.22	1.59	1.80	1.49	1.38	0.59	0.63	0.50
10.	Detergent	mg/l	200	200	200	200	8	5	2	5	3	2	7	4	3	3	3	2	4	3	3
11.	Iron (Fe)	mg/l	0.3	0.3	-	-	1.43	1.7	1.32	0.79	1.19	1.15	1.24	1.12	0.12	0.91	1.12	1.09	0.15	0.09	0.09
12.	Lead/Timbal (Pb)	mg/l	0.03	0.03	0.03	1	0.04	0.001	0.001	0.004	0.001	0.004	0.002	0.001	0.003	0.04	0.001	0.009	0.001	0	0.001
13.	Zinc (Zn)	mg/l	0.05	0.05	0.05	2	0.07	0.006	0.10	1.41	0.89	0.02	1.83	1.01	0.95	1.12	0.21	0.88	0.07	0.03	0.03
14.	Sulfide (H2S)	mg/l	0.002	0.002	0.002	-	1.41	1.91	1.6	1.15	1.11	1.30	2.6	1.91	1.19	1.31	1.09	0.06	0.81	0.71	0.38
15..	Phenol	mg/l	1	1	1	-	0.08	0.07	0.06	0.03	0.06	0.02	0.17	0.27	0.02	0.28	0.12	3.01	0.05	0.04	0.02
16.	Oil & Fat	mg/l	1000	1000	1000	-	10	6	7	8	13	9	9	5	5	3	1	1	4	4	2
17.	Copper (Cu)	mg/l	0.02	0.02	0.02	0.02	0	0	0	0.005	0	0	0	0	0	0	0	0	0	0	0
	C. Biological																				
18.	Coliform	mg/l	100	1000	2000	2000	36	25	26	14	8	9	48	28	22	34	30	28	10	7	5
19.	Colifecal	mg/l	1000	5000	10000	10000	17	18	14	7	6	7	19	17	16	19	14	11	3	2	2

4.4. Quality of Rural and Urban Effluent

The quality of rural and urban effluent on physical, chemical and Biological characteristics, water samples were collected from the Baturusa river, upstream and downstream from the hilly discharge of the Bangka regency to the lowland area. Most investigations on physical, chemical and biological characteristics in the aquatic habitat have concerned, because they are used as pollution indicators and may be associated with infectious diseases, and pollutant. Despitefully, however in many freshwater systems, fecal bacteria are of little numerical significance despite the fact that they are discharged into almost all inland waters. To determine the water quality in rivers in the Bangka Belitung islands is the collection of data relating to the methods of data collection and data processing as follows;

1. Location and sampling points

   Samples taken in two season (rainy/wet season on April 11, 2008 and dry season on July 2, 2008) from 5 points the river which consists of 4 rivers in the Bangka island i.e. Muntok river, Jering river, Jeruk river and the Gusung river and a river in the Belitung island i.e. Lenggang river as shows in table 4.3. Table 4.4. shows the points sampling location coordinates, while geographic location of water quality sampling, in each river were determined three sample points that the upstream, middle and downstream, thus the number of sample points of 15 points as shows in Table 4.4.

2. Methods of sampling and data collection techniques

Sampling methodes used in sampling is a "grab sample", is a momentary sampling method where te measured condition is at the time of making the river water. The technique or methode is done through method/techniques of literature and documentation in accordance with the type of data is as follows:

a. *Primary data*, primary data collection done by:

1) Direct measurements (field method) of the physical condition of the river, the physical condition of water (odor, turbidity, temperature) and chemical condition (pH, COD, BOD).

2) River water samples based on the parameters as shown in Table 4.1. and Table 4.2.

Table 4.3. Sampling location geographical coordinates of the river area.

S.No	Name of River	Location geographical coordinates of the river area		
		Upstream	**Middle**	**Downstream**
1.	Muntok river	2°02'45' South Latitude 105°09'37' East Longitude	2°03'03' South Latitude 105°09'49' East Longitude	2°04'06' South Latitude 105°09'45' East Longitude
2.	Jering river	1°56'45' South Latitude 105°36'21' East Longitude	1°58'11' South Latitude 105°35'30' East Longitude	1°59'48' South Latitude 105°35'28' East Longitude
3.	Jeruk river	2°55'49' South Latitude 106°23'21' East Longitude	2°57'38' South Latitude 106°22'32' East Longitude	2°57'52' South Latitude 10°623'08' East Longitude
4.	Gusung river	2°55'49' South Latitude 105°46'12' East Longitude	2°04'36' South Latitude 105°45'38' East Longitude	20°7'08' South Latitude 105°45'36' East Longitude
5.	Lenggang river	2°54'11' South Latitude 108°03'47' East Longitude	2°56'42' South Latitude 108°09'21' East Longitude	3°00'02' South Latitude 108°11'12' East Longitude

b. *Secondary data*, secondary data collection is done through method/ technical literature and documentation. Technical literature is reviewed literature on the theories relating to the object of research, while the technical documentatin that is collecting the data or information/reports from relevant agencies as well as the results of previous studies.

Table 4.4. Geographical location of the river water quality sampling points.

S.No.	Name of River	The river sampling points	Geographical location
1.	Muntok river	Upstream	Bridge of Menjelang Baru village, District of Muntok, Western Bangka regency.
		Middle	Bridge of Sidorejo village, District of Muntok, Western Bangka regency.
		Downstrean	Bridge of Muntok market, Tanjung village, District of Muntok, Western Bangka regency.
2.	Jering river	Upstream	Branch of Sungai Selan, Pangkaldengu village, District of Kelapa, Western of Bangka regency.
		Middle	Kayuarang village, District of Kelapa, Western of Bangka regency.
		Downstrean	Branch of Air Paninjau river, Pancor village, District of Kelapa, Western of Bangka regency.
3.	Jeruk river	Upstream	Branch of Tapak, District of Puding Besar, Bangka regency.
		Middle	Branch of Kotawaringin, Kotawaringin village, District of Puding besar, Bangka regency.
		Downstrean	About 4 km from estuary district of Puding Besar, Bangka regency.
4.	Gusung river	Upstream	Branch of Air Selak river, District of Toboali, Southern Bangka regency.
		Middle	Branch of Serunai river, Anda village, District of Toboali, Southern Bangka regency.
		Downstrean	Branch of Pendandatuk river, District of Toboali, Southern Bangka regency.
5.	Lenggang river	Upstream	Bridge of Lintang village, District of Gantung, Eastern Belitung regency.
		Middle	Gantung cross section, District of Gantung, Eastern Belitung regency.
		Downstrean	Complex of mining Kaolin sand, Gantung village, District of Gantung, Eastern Belitung regency.

CHAPTER V

Agriculture System

CHAPTER V

AGRICULTURE SYSTEM

5.1. Area and Production Crops

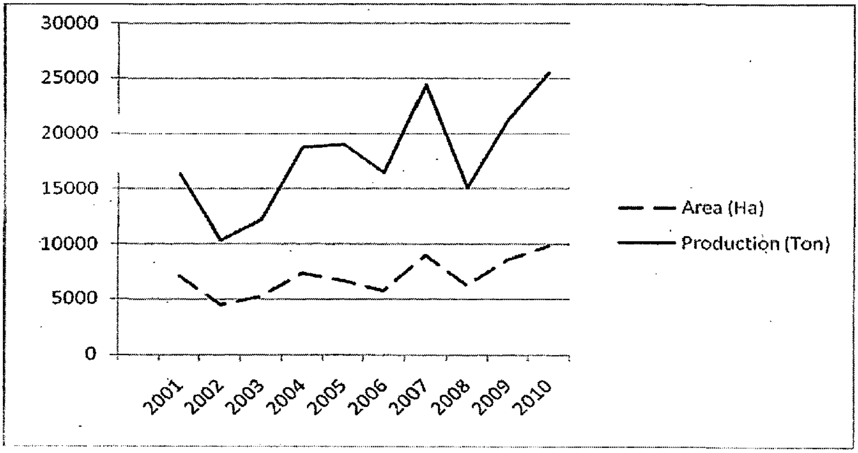
Area of land and rice production in the Bangka Belitung Islands from year to year fluctuations are influenced by various factors, with the planting area on average for 10 years an area of 6,234 ha while the largest area planted in 2010 covering an area of 9,877 ha and lowest in 2002 an area of 4,497 Ha. While the average productivity since the year 2001-2010 amounted to 25.34 Q/ha with the highest productivity occurred in 2006 amounted to 28.75 Q/ha and lowest in 2002 amounted to 22.94 Q/ha. The highest production occurred in 2010 amounting to 25,532.05 tonnes and the lowest in the year 2007 of 2,439.01 tonnes of this condition is the lowest production very significantly during the past 10 years caused by weather conditions that do not allow, with the average since the year 2001 to 2010 amounting to 15,746.08 tonnes. As shown in Table 5.1 and Figure 5.1 below.

Table 5.1. Area and production of crops.

Year	Area (Ha)	Productivity (Q/Ha)	Production (Ton)
2001	7,130	23.04	16,427.52
2002	4,497	22.94	10,316.12
2003	5,234	23.25	12,173.70
2004	7,402	25.35	18,764.07
2005	6,691	28.44	19,029.20
2006	5,741	28.75	16,505.38
2007	9,010	27.07	24,390.07
2008	6,266	24.06	15,076.00
2009	8,603	24.64	21,197.79
2010	9,877	25.85	25,532.05
Average	**6,234**	**25.34**	**15,746.08**

Source : Central Statistical Agency, (2010)

Figure 5.1. Area and production crop.



5.2. Calendar of Operation of Crops

Generally, there are two major cultivation seasons associated with two monsoons and they are know as rainy season and dry season. The rainy season between October – March and dry season between April – September. The cropping pattern used is Rice-Rice-Crop. Rice fields are usually planted during the rainy season, rice planting time in October/November and harvest in January/February. In the dry season, when planting rice after the rice harvest season in January/February and harvested in May. Most of that is over 80 percent of farmers use the new varieties (VUB/Varitas Unggul Baru) Ciherang. After planting rice paddy I and paddy II, followed by planting crops of soybean. Soybean planting is better in early May and harvested in August/September. (as shown in Figure 5.2.). Based on the experience of farmers, soybean planting should be early May, when the planting is done after many months of the soybean crop pests.

Horticultural crops grown as a crop side, farmers working on the wetland section is in the high/dike fields such as cucumbers, long beans, kale, peppers, eggplant and spinach. With rice-paddy cropping pattern-pulses, rice cropping intensity of the rainy season and dry season crops reached 100 percent, while only 40-60 percent and the rest/not be planted because the land is low but there is a use it.

Fig 5.2. Calendar of operation of crops

Month	1	2	3	4	5	6	7	8	9	10	11	12
Wet land	Paddy				Crop					Paddy		

5.3. Pesticide Use System

The use of pesticides without following the rules can given endanger human health and the environment also can damage the ecosystem. With the presence of pesticides, to increase agricultural production and farmer's welfare is also getting better. Because pesticides are poisons that can also kill useful organisms even the user's life can also be threatened if the use does not fit the established procedure. Poisoning incident can not tackle anymore because most farmers use chemical pesticides are very bad for their health rather than chemical pesticides on botanical pesticides (artificial). The precautions that need to be addressed:

1. Know and understand with certainty about the usefulness of a pesticide. Make no mistake eradicate. For example, herbicides should not be used to eradicate the insect. As a result, the insect is not necessarily dead, while the soil and the plant has already polluted.

2. Follow the instructions on the rules of use and the recommended dose or factory extension workers.
3. Do not be too hasty to use pesticides.
4. Do not be late to eradicate the pest, when the extension has been suggested to use it.
5. Make no mistake in using pesticides. See other factors such as types of pests and plant age are sometimes also considered.
6. Use a special place for the dissolution of pesticides and should not be scattered.
7. Understand how to use pesticides properly.

5.3.1. Regulation

The use of pesticides regulated by:

1. The Minister of Farming Regulation Letter No. 434.1/Kpts/TP.270/7/2001 and the Commission of Pesticides Regulation Year 2004 of Conditions and Manner of Pesticide Use Listing, regulates certain pesticides for limited use only (e.g., ramoxone/noxone with paraquat as its active ingredient, and Supracide/Supretox with methidathion as its active ingredient). Limited use pesticides can only be used International (POPs/Persistent Organic Pollutants) Elimination Project – IPEP.
2. There are pesticides that are sold freely even though its circulation permit has been expired, or are not in the government list of licensed pesticides. This practice goes against the Minister of Farming

Regulation Letter No. 280/Kpts/UM/9/1973 (Pesticides Application List and Permit Procedures) and the Minister of Farming Regulation Letter No. 473/Kpts TP.270/6/1996 on the Listing and Permit Stoppage for Use on Managing Plants.

3. The sale of locally packaged pesticides without any label is also against the Minister of Farming Regulation Letter No. 429/Kpts/TP.270/9/1973 on the Standard Conditions on Pesticides Packaging and Labeling.
4. The sale of pesticides along with other products (farming tools, cattle feed, human foods/drinks) without any partition poses a danger to the safety of human health and the environment. Without any partition, pesticides can contaminate the other products.

5.3.2. Pesticides and solvent materials

Active toxic pesticides as a material (active ingredient) in the formulation is usually expressed in weight/volume (in the United States and Britain) or heavy-weight (in Europe). Other materials that are not active which were mixed in a pesticide that has been formulated to be:

- ✓ Solvent is a liquid solvent such as alcohol, kerosene, xylene and water. Usually, these solvents have given deodorant (unpleasant odor remover material either from solvent or from the active ingredient).
- ✓ Synergy, a kind of material that can increase the toxicity, although the material itself may not be toxic like sesamin (derived from sesame seeds), and piperonil butoxide.

- ✓ Emulisifier, a detergent ingredient that will facilitate the occurrence of oil emulsion when diluted in water.
- ✓ Besides the materials mentioned above, as appropriate, in the formulation added to other materials such as fire suppression, an unpleasant odor remover (Deodorizer).

5.3.3. Dose, dose concentration and application

Dose (dosage), is the number (volume) poison (the active ingredient, although in practice in question is the product formulation) is applied to a unit area or volume, for example: 1 liter/ha area, 100 cc/m^3. The dose of pesticide for a purpose is usually fixed, although concentration may vary.

Dose, is number of toxins (usually expressed in weight, mg) needed to enter the body of organisms and can turn it off, such as lethal dose (LD) is expressed in mg/kg (mg of active ingredient per kg body weight of the target organism).

Concentration, is the ratio (percentage) between the active ingredient with a diluent material, solvent and/or carrier.

5.3.4. Toxicology

The compounds (organochlorin, chlorinated hydrocarbons), most of causing damage to the components of nerve cell sheaths (Schwann cells) so that the disturbed nerve function. Poisoning can cause death or recovery. Recovery was not caused the compound has been out of the body but as stored in body fat. All insecticides difficult decomposed by environmental factors and are persistent, and tend to stick to the fat and particles of soil so that the body remains alive to the accumulation, as well as in soil. As a result of poisoning is usually felt after a long time, especially when the dose of death (lethal dose) is achieved. This is what causes so that the use of organochlorin in the current increasingly reduced and restricted.

Another effect is biomagnification, namely improvement of environmental poisoning that occurs because biomagnification effects (increased biological) that is an increase of the toxic substance occurs in the body remains alive, because of certain biological reactions. All the compounds (organophospates) and carbamates are obstacles ChE (enzyme choline esterase), enzymes that play a role in forwarding nerve stimulation. Poisoning can occur because of disturbances in nervous system function that will cause death or can be recovered. Age residues of organochlorin and carbamates did not last long so that the chronic poisoning of the environment tend not to occur because of environmental factors easy to describe the compounds of organophosphate and family planning becomes a non-toxic components. However this compound is an acute poison, so their use is very safety factors to consider. Because of the danger it caused in the environment did not last long, most of the insecticides and most fungicides used today are from the class of organophosphate and carbamates.

The parameters used to assess the effects of pesticide poisoning to mammals and humans is the LD_{50} (lethal dose 50%) showing the amount of pesticide in milligrams (mg) for each kilogram (kg) weight of an animal-testing, which can kill 50 animals of similar among 100 individuals who are given the dose. Need to know in practice is an acute oral LD_{50} (ingested) and acute dermal

LD_{50} (skin is absorbed). LD_{50} values obtained from the experiment with rats. LD_{50} values are high (above 1000) showed that pesticides are concerned not so dangerous to humans. LD_{50} is low (below 100) shows the opposite.

5.4. Fertilizer Use System

In order to succeed the program to improve rice production, the reference site-specific fertilization is needed. The low productivity of these paddy fields caused by a lack of nutrient availability in soil (Sudaryono, 1994; Suyamto, 1994). Nutrients needed by rice plants can be provided through fertilization. nitrogen (N), phosphorus (P) and potassium (K) is the nutrient most needed for paddy fields than any other nutrient.

N, P and K were added to the soil should be in the right amount. The type of soil, the level of nutrient availability in the soil, climatic conditions, rice varieties are grown and how the provision of fertilizer will greatly determine the assessment type and dose of fertilizer should be added. To produce rice as much as 3 t/ha, it takes about 54 kg nutrients N, 60 kg P_2O_5 and 55 kg K_2O/ha/season (Djaenuddin et al., 2000). For comparison, the results of research Idris et al. (2002) showed that fertilization 90 kg N, 72 kg P_2O_5 and 50 kg of dry milled grain yield K_2O/ha/season +5.4 t/ha/season. Excess or shortage of nutrients will affect the efficiency of nutrient absorption due to the disruption of nutrient in soil and plant metabolism. In addition, excess nutrients can also damage the environment, triggers other nutrients. Lowland rice production center has a diverse agroecology. Therefore, the reference is very site-specific fertilization is needed for fertilization to reach a high level of efficiency.

N deficiency symptoms; N deficiency can cause the leaves turn yellowish-green to yellow in full, slow and stunted plant growth, and the symptoms become more severe again dried leaves from the bottom continue to miss out on. *P deficiency symptoms*; P deficiency can cause a reduced root and grow. In the event of severe P deficiency, leaves, branches, and stems are purple. Declining crop yields. *K deficiency symptoms;* K deficiency causes slow growth and stunted plants. Lower leaf burning on the edges and ends, and fall prematurely. Plants easily broken and fall down. Leaves at first shrank and shiny, then at the leaf tip and edges begin to look color-brass forehead which spread among the bones of leaves. Then look red-brown spots and eventually leaf death.

5.4.1. The Importance of Balanced Fertilization

Balanced fertilization primarily a balance between Urea, SP-36/TSP and KCI to be provided depending on soil conditions. The key ingredients contained in these fertilizer if used properly does not just control, balance, support and complement one another among the three. This very important because there are economic linkages and fertilization efectivity. Fertilizer provided is in addition to existing elements in the soil, so the amount of nitrogen, phosphorus and potassium available to plants are in a proper comparison. At the same time the availability of essential elements are also optimal circumstances. For example if the rice fertilization fertilized only with urea alone, it seems very fast and dense but very weak so easy rebate and can not stand, against pests and diseases. And vice versa, if only fostered TSP/SP-36 or KCI alone this fertilizer will have no effect on growth and optimal crop production. In principle, the deficits or fertility as a whole must be such so as to enhance plant growth is dense and normal.

5.4.2. Time of giving Fertilizer N, P and K

Timing of fertilizer tailored to the level of plant growth and type of fertilizer that will ensure for optimal absorption of the fertilizer by the plants. Granting of TSP / SP-36 are generally given together planting, while urea is given twice, ½ dose at planting (one week after planting) ½ dose 35-40 days after planting (when the plant is active). KCL fertilizer, the principle of less but more often, it's better than giving in large quantities but given all at once to ensure effective absorption of nutrients from fertilizers KCL, then the gift is adjusted with a growth rate of rice plant that is 1/3 dose 1 weeks after planting, 1/3 dose 35-40 days after planting (during active chicks) and the third dose 55 days after planting when primordia).

5.4.3. Procedures on Fertilizer

Particular interest to reduce the decline in the availability of fertilizer is the time and manner of fertilizer. Giving the right fertilizer for paddy rice plant growth can increase the efficiency of fertilizer use. The nature of N fertilizer generally soluble in water, so easily lost, either through leaching or evaporation. To reduce loss of N, N fertilizer should be given in stages, ie half the dose of fertilizer N and all P and K fertilizer doses given at the beginning of planting, while the half dose of fertilizer N is given at age 35-40 days after planting, the provision of fertilizer by road sow evenly on the surface of land/rice fields with water conditions +5 cm. Preparation of reference paddy fertilizer recommendation based on the results of analysis of land and rice fertilization research by the Center for Technology Assessment or other.

Determination of fertilizer recommendation based on soil nutrient status and crop needs. The phylosophy is on soil with low nutrient status, response to fertilization is very high, the status of being a little response and the high nutrient status of plants do not respond anymore. That is, the higher soil nutrient status did not affect the production of fertilizer, the status is affecting the production and the low status significantly affect production. Reference dose recommendations are presented in the form of nutrients, so it can use any type of fertilizer available in the market, provided that the content of ingredients according to the needs of reference that have been determined.

5.4.4. Fertilizer Application

Fertilization is done manually with the spread or scattered evenly on the plant area. For applications of urea and KCl at the same time can be mixed evenly before and after mixed diaflikasikan must be sown, should not be stored for too long. The results of research use of Urea, SP-36 and KCL shown that the concentration of urea, SP-36 and KCl (200 kg/ha, 150 kg/ha) gave the highest yield, i.e. 6.66 tonnes/ha in variety Membramo (A. Wahid Rauf at. Al, 1998). Regarding the physical and economic efficiency of these fertilizers can be seen in Table 5.3. below.

In the table below shows that the use of urea fertilizer with a combination of 200 Kg/ha, SP-36 100 kg/ha and KCL 150kg/ha could increase rice yield 6.66 tonnes/ha, with physical efficiency is high at 10.8 kg of grain dry/kg. The combination of fertilizer with the economic efficiency of 5.1 means that each output of one unit for the use of fertilizer N, P, K to give a revenue of 5 units.

Table 5.3. Production and efficiency of urea fertilizer, SP-36, KCL

Doses of fertilizer (Kg/ha)	Doses of KCL fertilizer (Kg/ha)					
	100		150		200	
	Prod.	Eff.	Prod.	Eff.	Prod.	Eff.
Urea 100						
SP-36 50	4.08	12.5 (6.25)	4.59	11.9 (5.4)	4.92	10.9 (4.6)
100	5.09	13.7 (6.25)	4.95	11.0 (5.1)	5.57	11.0 (4.2)
150	4.64	10.0 (5.00)	4.35	7.8 (3.4)	4.81	9.5 (4.2)
Urea 150						
SP-36 50	5.10	13.7 (7.20)	5.14	11.6 (5.5)	5.60	11.1 (5.0)
100	5.57	12.9 (6.70)	5.81	11.6 (5.6)	6.38	11.5 (5.2)
150	5.47	10.8 (5.00)	5.58	9.7 (4.7)	5.85	9.1 (4.1)
Urea 200						
SP-36 50	5.27	12.6 (6.80)	5.27	10.2(5.1)	5.20	8.8 (4.1)
100	5.33	10.4 (5.60)	5.76	10.1(5.1)	6.66	10.8 (5.1)
150	5.14	8.7 (4.60)	5.04	7.5 (3.8)	5.14	6.9 (3.2)
Prod = Production (t/ha) Eff = Efficiency of physical (Figures in brackets show the economic efficiency)						

Source: A. Wahid Rauf et. al. (1998).

5.5. Miscellaneous Chemical Use System

Agrochemical (or agrichemical), a contraction of agricultural chemical, is a generic term for the various chemical products used in agriculture. In most cases, agrichemical refers to the broad range of pesticides, including insecticides, herbicides, and fungicides. It may also include synthetic fertilizers, hormones and other chemical growth agents, and concentrated stores of raw animal manure.

Many agrichemicals are toxic, and agrichemicals in bulk storage may pose significant environmental and/or health risks, particularly in the event of accidental spills. In many countries, use of agrichemicals is highly regulated. Government-issued permits for purchase and use of approved agrichemicals may be required. Significant penalties can result from misuse, including improper storage resulting in spillage. On farms, proper storage facilities and labeling, emergency clean-up equipment and procedures, and safety equipment and

5.5.1.2. Spray application

One of the more common forms of pesticide application, especially in conventional agriculture, is the use of mechanical sprayers. Hydraulic sprayers consists of a tank, a pump, a lance (for single nozzles) or boom, and a nozzle (or multiple nozzles). Sprayers convert a pesticide formulation, often containing a mixture of water (or another liquid chemical carrier, such as fertilizer) and chemical, into droplets, which can be large rain-type drops or tiny almost-invisible particles. This conversion is accomplished by forcing the spray mixture through a spray nozzle under pressure. The size of droplets can be altered through the use of different nozzle sizes, or by altering the pressure under which it is forced, or a combination of both. Large droplets have the advantage of being less susceptible to spray drift, but require more water per unit of land covered. Due to static electricity, small droplets are able to maximize contact with a target organism, but very still wind conditions are required.

5.5.1.2.1. Spraying pre and post-emergent crops

Traditional agricultural crop pesticides can either be applied pre-emergent or post-emergent, a term referring to the germination status of the plant. Pre-emergent pesticide application, in conventional agriculture, attempts to reduce competitive pressure on newly germinated plants by removing undesirable organisms and maximizing the amount of water, soil nutrients, and sunlight available for the crop. An example of pre-emergent pesticide application is atrazine application for corn. Similarly, glyphosate mixtures are often applied pre-emergent on agricultural fields to remove early-germinating weeds and prepare procedures for handling, application and disposal are often subject to mandatory standards and regulations.

5.5.1. Chemical pesticides

Pesticide application refers to the practical way in which pesticides, (including herbicides, fungicides, insecticides, or nematode control agents) are delivered to their *biological targets* (*e.g.* pest organism, crop or other plant). Public concern about the use of pesticides has high-lighted the need to make this process as efficient as possible, in order to minimise their release into the environment and human exposure (including operators, bystanders and consumers of produce). The practice of pest management by the rational application of pesticides is supremely multi-disciplinary, combining many aspects of biology and chemistry with: agronomy, engineering, meteorology, socio-economics and public health, together with newer disciplines such as biotechnology and information science.

5.5.1.1. Seed treatments

Seed treatments can achieve exceptionally high efficiencies, in terms of effective dose-transfer to a crop. Pesticides are applied to the seed prior to planting, in the form of a seed treatment, or coating, to protect against soil-borne risks to the plant; additionally, these coatings can provide supplemental chemicals and nutrients designed to encourage growth. A typical seed coating can include a nutrient layer—containing nitrogen, phosphorus, and potassium, a rhizobial layer—containing symbiotic bacteria and other beneficial microorganisms, and a fungicide (or other chemical) layer to make the seed less vulnerable to pests.

for subsequent crops. Pre-emergent application equipment often has large, wide tires designed to float on soft soil, minimizing both soil compaction and damage to planted (but not yet emerged) crops.

Post-emergent pesticide application requires the use of specific chemicals chosen minimize harm to the desirable target organism. An example is 2,4-Dichlorophenoxyacetic acid, which will injure broadleaf weeds (dicots) but leave behind grasses (monocots). A number of companies have also created genetically-modified organisms that are resistant to various pesticides. Examples include glyphosate-resistant soybeans and Bt maize, which change the types of formulations involved in addressing post-emergent pesticide pressure. It is important to also note that even given appropriate chemical choices, high ambient temperatures or other environmental influences, can allow the non-targeted desirable organism to be damaged during application. As plants have already germinated, post-emergent pesticide application necessitates limited field contact in order to minimize losses due to crop and soil damage.

Typical industrial application equipment will utilize very tall and narrow tires and combine this with a sprayer body which can be raised and lowered depending on crop height. These sprayers usually carry the label 'high-clearance' as they can rise over growing crops, although usually not much more than 1 or 2 meters high. In addition, these sprayers often have very wide booms in order to minimize the number of passes required over a field, again designed to limit crop damage and maximize efficiency. In industrial agriculture, spray booms 120 feet (40 meters) wide are not uncommon, especially in prairie agriculture with large, flat fields. Related to this, aerial pesticide application is a method of top dressing a pesticide to an emerged crop which eliminates physical contact with soil and crops.

Air Blast sprayers, also known as air-assisted or mist sprayers, are often used for tall crops, such as tree fruit, where boom sprayers and aerial application would be ineffective. These types of sprayers can only be used where overspray-spray drift-is less of a concern, either through the choice of chemical which does not have undesirable effects on other desirable organisms, or by adequate buffer distance. These can be used for insects, weeds, and other pests to crops, humans, and animals. Air blast sprayers inject liquid into a fast-moving stream of air, breaking down large droplets into smaller particles by introducing a small amount of liquid into a fast-moving stream of air.

Foggers fulfill a similar role to mist sprayers in producing particles of very small size, but use a different method. Whereas mist sprayers create a high-speed stream of air which can travel significant distances, foggers use a piston or bellows to create a stagnant area of pesticide that is often used for enclosed areas, such as houses and animal shelters.

5.5.1.2.2. Spraying inefficiencies

In order to better understand the cause of the spray inefficiency, it is useful to reflect on the implications of the large range of droplet sizes produced by typical (hydraulic) spray nozzles. This has long been recognized to be one of the most important concepts in spray application (*e.g.* Himel, 1969), bringing about enormous variations in the properties of droplets. Historically, dose-transfer to the biological target (*i.e.* the pest) has been shown to be inefficient. However, relating "ideal" deposits with biological effect is fraught with difficulty), but in spite of Hislop's misgivings about detail, there have been several demonstrations that massive amounts of pesticides are wasted by run-off from the crop and into the soil, in a process called endo-drift. This is a less familiar form of pesticide drift, with exo-drift causing much greater public concern. Pesticides are conventionally applied using hydraulic atomisers, either on hand-held sprayers or tractor booms, where formulations are mixed into high volumes of water.

Different droplet sizes have dramatically different dispersal characteristics, and are subject to complex macro and micro-climatic interactions (Bache & Johnstone, 1992). Greatly simplifying these interactions in terms of droplet size and wind speed, Craymer & Boyle concluded that there are essentially three sets of conditions under which droplets move from the nozzle to the target. These are where:

- sedimentation dominates: typically larger (>100 μm) droplets applied at low wind-speeds; droplets above this size are appropriate for minimising drift contamination by herbicides.
- turbulent dominates: typically small droplets (<50 μm) that are usually considered most appropriate for targeting flying insects, unless an electrostatic charge is also present that provides the necessary force to attract droplets to foliage. (NB: the latter effects only operate at very short distances, typically under 10 mm.)
- intermediate conditions where both sedimentation and drift effects are important. Most agricultural insecticide and fungicide spraying is

optimised by using relatively small (say 50-150 μm) droplets in order to maximize coverage (droplets per unit area), but are also subject to drift.

5.5.1.2.3. Improved targeting

Improved application technologies such as controlled droplet application (CDA) received extensive research interest, but commercial uptake has been disappointing. By controlling droplet size, ultra-low volume (ULV) or very low volume (VLV) application rates of pesticidal mixtures can achieve similar (or sometimes better) biological results by improved timing and dose-transfer to the biological target (*i.e.* pest). No atomizer has been developed able to produce uniform (monodisperse) droplets, but rotary (spinning disc and cage) atomizers usually produce a more uniform droplet size spectrum than conventional hydraulic nozzles. Other efficient application techniques include: banding, baiting, specific granule placement, seed treatments and weed wiping.

CDA is good examples of a rational pesticide use (RPU) technology (Bateman, 2003), but unfortunately has been unfashionable with public funding bodies, with many believing that all pesticide development should be the responsibility of pesticide manufacturers. On the other word, pesticide companies are unlikely widely to promote better targeting and thus reduced pesticide sales, unless they can benefit by adding value to products in some other way. RPU contrasts dramatically with the promotion of pesticides, and many agrochemical concerns, have equally become aware that product stewardship provides better long-term profitability than high pressure salesmanship of a dwindling number of new "silver bullet" molecules. RPU may therefore provide an appropriate framework for collaboration between many of the stake-holders in crop protection. Understanding the biology and life cycle of the pest is also an important factor in determining droplet size. The Agricultural Research Service, for example, has conducted tests to determine the ideal droplet size of a pesticide used to combat corn earworms.

5.5.2. Chemical fertilizers

Fertilizers are soil amendments applied to promote plant growth, the main nutrients present in fertilizer are nitrogen, phosphorus, and potassium (the macronutrients) and other nutrients (micronutrients) are added in smaller amounts. Fertilizers are usually directly applied to soil, and also sprayed on leaves (foliar feeding). Fertilizers are roughly broken up between organic and inorganic fertilizer, with the main difference between the two being sourcing, and not necessarily differences in nutrient content.

5.5.2.1. Fertilizer analysis

Understanding the fertilizer analysis is essential when choosing the right fertilizer to purchase and apply. Fertilizers, such as 10-20-10, are identified on their package by their chemical analysis. The three numbers on the bag or container refer to the percentages of nitrogen, phosphorus, and potassium components in the fertilizer. Water soluble types are mixed with water and the feeding is accomplished by sprinkling onto the leaves of the plant (foliar feeding) or used as part of the watering process, in which the plant takes in the nutrients systemically (through the roots). Fertilizer components and what each does for plants.

1. The first number in a fertilizer formula is the nitrogen content. Nitrogen is used by plants for producing leaf growth and greener, lusher leaves.
2. The second number in a fertilizer formula is the phosphorus content. Phosphorus is used by plant to increase fruit development and to produce a strong root system.
3. The third number in a fertilizer formula is the potassium (potash) content. Potassium is used by plants for flower color and size. It is also important to the strength of the plant.

5.5.2.2. Using fertilizers properly

The easiest way to explain this would be that a 100 bag of 10-20-10 converted to component weight would equal 25 of nitrogen, 50 of phosphate, and 25 of potash. Before applying fertilizer, best to test your soil (or have it tested by sending a sample to local county agent). These soil tests the level of nutrients that are already in the soil, as well as the acidity (pH) of the soil. Adjusting the pH of the soil is essential, because some nutrients may become unavailable to plants if the soil pH is above or below a certain range. If test is done by county extension service, the test results will be much more detailed, and will also provide their recommendations for any needed additions of lime and fertilizer to soil.

The timing of the application of fertilizers is very important. Too much fertilizer or applying it at the wrong time can lead to an over abundance of foliage, delayed flowering, leaf and root burn, or even plant death due to excess fertilizer. It is essential that always read and follow the product recommendations for fertilizers, or any other chemicals.

CHAPTER VI

Pollution from Agriculture Activities

CHAPTER VI

POLLUTION FROM AGRICULTURE ACTIVITIES

6.1. General

Non-point Source (NPS) pollution was not recognized until the mid-1960s. At first NPS pollution was associated entirely with pollution from storm water and runoff. Since that time NPS pollution has expanded to encompass all forms of diffuse pollutants. NPS pollutants are defined as "contaminants of air, surface and subsurface soil and water resources that are diffuse in nature and cannot be traced to a point location" (Corwin and Wagenet, 1996). Often NPS pollutants occure naturally, e.g., as salt and trace elements in soils, or are the consequence of direct application by humans (e.g., pesticides and fertilizers), but regardless of their source they are generally the direct consequence of human activities including agriculture, urban runoff, feed lots, hydro modification, and resource extraction.

Specially, NPS pollutants include: (1) excess fertilizers herbicides, and insecticides from agricultural lands and residential area; (2) oil, grease, and toxic chemicals from urban runoff and energy production; (3) sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks; (4) naturally occuring saltsand trace elements from irrigation practices; (5) acid drainage from abandoned mines; (6) pathogens (i.e., virus and bacteria) and nutrients from livestock, and pet wastes, and (7) atmospheric decomposition.

Characteristically, NPS pollutants (1) are difficult or imposible to trace to a source; (2) enter the environment over an extensive area; (3) are related, at least in part, to certain uncontrollable meteorogical event, and existing geographic and geomorfologic conditions; (4) have the potential for maintaining a relatively long active presence in the global ecosystem; and (5) may result in long-term chronic effect on human health and soil-aquatic degradation.

Pollution is the introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to the ecosystem i.e. physical systems or living organisms. Pollution can take the form of chemical substances or energy, such as noise, heat, or light. The elements of pollution, can be foreign substances or energies, or naturally occurring; when naturally occurring, they are considered contaminants when they exceed natural levels. Pollution is often classed as point source or nonpoint source pollution.

A pollutant is a waste material that pollutes air, water or soil. Three factors determine the severity of a pollutant: its chemical nature, the concentration and the persistence. Pollution has been found to be present widely in the environment. There are a number of effects of this:

- ✓ Biomagnification describes situations where toxins (such as heavy metals) may pass through trophic levels, becoming exponentially more concentrated in the process.
- ✓ Carbon dioxide emissions cause ocean acidification, the ongoing decrease in the pH of the Earth's oceans as CO_2 becomes dissolved.
- ✓ The emission of greenhouse gases leads to global warming which affects ecosystems in many ways.
- ✓ Invasive species can out compete native species and reduce biodiversity. Invasive plants can contribute debris and biomolecules (allelopathy) that can

alter soil and chemical compositions of an environment, often reducing native species competitiveness.

- ✓ Nitrogen oxides are removed from the air by rain and fertilise land which can change the species composition of ecosystems.
- ✓ Smog and haze can reduce the amount of sunlight received by plants to carry out photosynthesis and leads to the production of tropospheric ozone which damages plants.
- ✓ Soil can become infertile and unsuitable for plants. This will affect other organisms in the food web.
- ✓ Sulphur dioxide and nitrogen oxides can cause acid rain which lowers the pH value of soil.

The major forms of pollution are listed below along with the particular pollutants relevant to each of them:

- ✓ Air pollution, the release of chemicals and particulates into the atmosphere. Common gaseous air pollutants include carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Particulate matter, or fine dust is characterized by their micrometre size PM10 to PM2.5 (Particles measuring of 10 micrometers or less and PM 2.5 represents particles less than 2.5 micrometers).
- ✓ Light pollution, includes light trespass, over-illumination and astronomical interference.
- ✓ Noise pollution, which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.

- ✓ Soil contamination occurs when chemicals are released by spill or underground leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, herbicides, pesticides and chlorinated hydrocarbons.
- ✓ Radioactive contamination, resulting from 20th century activities in atomic physics, such as nuclear power generation and nuclear weapons research, manufacture and deployment.
- ✓ Thermal pollution, is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant.
- ✓ Visual pollution, which can refer to the presence of overhead power lines, motorway billboards, scarred landforms (as from strip mining), open storage of trash or municipal solid waste.
- ✓ Water pollution, by the release of waste products and contaminants into surface runoff into river drainage systems, leaching into groundwater, liquid spills, wastewater discharges, eutrophication and littering.

The most common global NPS pollutants of soil and groundwater resources include biosolids and manure, persistent organic pollutants (POPs), nutrients (e.g., Nitrate and phosphates). Salinity, toxic heavy metals (e.g., Bi, Co, Sn, Te, Ag, Pt, Tl, Sb, Hg, As, Pb,Cd, Cr, Ni), trace elements (e.g., Se, B, Mo, Cu, Zn), and pathogens. Each type of pollutant is directly associated with agriculture activity. Table 6.1. shows the relative importance of each NPS pollutant with respect to its source.

Table 6.1. Relative Importance of Pollutant Concentration in Soil-Water Systems

Non-point Source	Suspended solids and sediments	BOD	Nutrients	Toxic metals	Trace elements	Pesticides	Pathogens	Salinity/ TDS
Urban storm runoff	M	L-M	L	H	M	L	H	M
Construction	H	N	L	N-L	N-L	N	N	N
Highway deicing	N	N	N	N	N	N	N	H
In-stream hydrologic modification	-	H-N	-	N-H	N-H	N	N	N-H
Non coal mining	H	N	N	MH	M-H	M-H	N	M-H
Agriculture								
Non irrigated crop production	H	M	H	N-L	N-L	H	N-L	N
Irrigated crop production	L	L-M	H	N-L	H	M-H	N	H
Pasture and range	L-M	L-M	H	N	N-L	N	N-L	N-L
Animal production	M	H	M	N-L	N-L	N-L	L-H	N-L
Forestry								
Growing	N	N	L	N	N	L	N-L	N
Harvesting	M-H	L=M	L-M	N	N	L	N	N
Residuals management	N-L	L-H	L-M	L-H	N-H	N	L-H	N-H
On-site sewage disposal	L	M	H	L-M	L-M	L	H	N
In-stream sludge accumulation	-	H	-	M=H	L-H	L-H	M-H	L
Direct precipitation	N	N	N-M	L	L	L	N-L	N
Air pollution fallout	M	L	L-M	L=H	N-M	L-M	N-L	N
'Natural' background	-	L=M	L-H	NM	N-M	N	N-L	N-H

N = Negligible; L = Low; M = Moderate; H = Hight; TDS = Total Dissolved Solids.

Source : Peirce et al., 1998

6.2. Mechanism Analysis

Multipurpose in developing countries are essential in view of agriculture based economy and large demand for water and energy. Table 6.2 shows possible environmental changes (soil. air, water, biota) and Table 6.3 shows areas of concern for human beings due to various impacts.

Table 6.2. Environment Changes

Medium	Changes and Rates of Change in
SOIL	▪Quality (e.g., depth, structure, fertility, degree of salination or acidification, etc). ▪Stability (geology/seismology) ▪Area of arable and ▪Mineral Resources depletion
AIR	▪Quality ▪The climatic elements
WATER	▪Quantity ▪Quality ▪Seasonality ▪Area of man-made lakes ▪Extent of irrigation canals
BIOTA	▪Abundance/scarcity of species or genetic resources ▪Extent of crops, vegetation, and forests ▪Diversity of species ▪Extent of provision of nesting grounds, etc. for migratory species ▪Abundance/scarcity of pests and disease organisms

Depending upon the purpose of agriculture and size of physical works, environmental changes in soil, air, water, biota and extent of human concern may be different. Figure 6.1. shows environmental impacts of irrigated agriculture. Table 6.4. shows impacts of increased sediment load of water.

Table 6.3. Areas of Human Concern (Impact Categories)

Impact Category	Human Concern
1. Economic and occupational	Displacement of population: relocation of population.
2. Social pattern or life style	Resettlement; rural depolutation; change in population density; food; housing; material goods; nomadic; settled; pastoral agricultural; rural; urban.
3. Social amenities and relationship	Family life style; schools transportation; community feelings; participation vs alienation.

Source : Munn,1979

Environmental Impact Assessment (EIA) may be defined as a formal process used to predict the environmental consequences of any development project. EIA thus ensures that the potential problems are foreseen and addressed at an early stage in the projects planning and design. EIA, in brief, extrapolates from scientific knowledge to assess the problem consequences of some human interventions on nature. Although EIA uses the techniques of science, it differs from ordinary scientific inquiry, because it is dealing with events which have not yet occurred, may not occur, and whose chances of occurrence may be changed by the very statement that they may occur. EIA is a tool that seeks to ensure sustainable development through the evaluation of those impacts arising from a major activity (policy, plan, program, or project) that are likely to have significant environmental effects. Some measures are required to be built in the project or to be taken in the future to reduce the anticipated environmental degradation. Before starting a major project, it is essential to assess the present environment without the project, and the likely impact of the project on the environment, when it is completed.

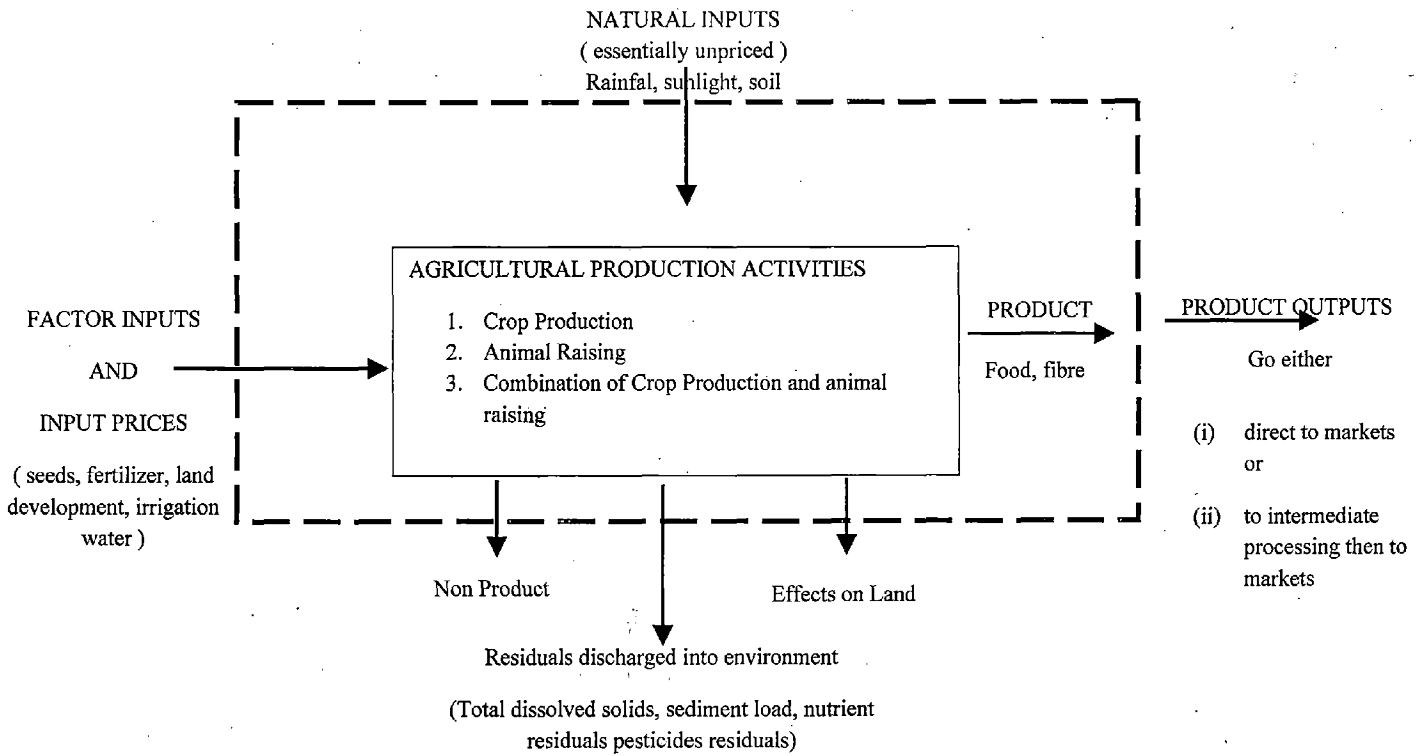


Figure 6.1. Environmental Impacts of Irrigated Agriculture

Table 6.4. Impacts of Increased Sediment Load of Water.

A. IN-STREAM	1. Biological • Turbidity • Sedimentation • Reduced Productivity • Species diversity
	2. Recreational • Restriction on water use • Fishing and Boating • Aesthetics
	3. Sedimentation of channels • Reservoir sedimentation • Impairment of navigation • Siltation of training structures
	4. Increased abrasion of hydraulic equipment – turbines etc.

B. OFF-STREAM	1. Flood damage • Agredation • Degradation
	2. Sedimentation of Conveyance System • Irrigation channels • Drainage channels
	3. Cost of Water Treatment • Increased sedimentation time • Clogging of filters
	4. Impairment of Industrial Water • Reduced cooling efficiency • Abrasion of pumps and turbines
	5. Scaling of Irrigation Soils
	6. Pollution Problems • Fine sediments • Pesticides & Nutrients

Environment Impact Assessment has to be made before starting a project. For analysis of environmental impacts, many professions and disciplines have to be involved. Like economic and engineering feasibility studies, Environmental Impact Assessment is a management tool for decision makers and project managers who make important decisions about major development projects.

6.3. Impact on Health of Crops

Plant absorb mineral elements indiscriminately from the rooting medium, but the presence in a plant of any particular element does not of itself constitute proof that the element is essential to its development. Arnon has made the following points in this regard:

- ✓ A deficiency of the element makes it impossible for the plant to complete the vegetative or reproductive stage of its life.
- ✓ The deficiency symptom of the element in question can be prevented or corrected only by supplying the element.
- ✓ The element is directly involved in the nutrition of the plant, quite a part from its possible effect in correcting some microbiological or chemical condition in the soil or culture medium.

The roles of the various mineral elements in plant growth are covered briefly in the following section:

- ➢ Nitrogen. Nitrogen is vitally important plant nutrient, the supply of which can be controlled by man. This element, to be absorbed by most plant must be in a form other than elemental nitrogen. The forms most commonly assimilated by plants are the nitrate (NO_3-) and the ammonium (NH_4+) ions. Urea (NH_2CONH_2) may also be absorbed by plants. Plant are generally able to utilize either of the two ionic forms of nitrogen. In nutrient or sand cultures some plant species achieve good growth with the ammonium form, whereas other species do better with the nitrate. Still other species grown equally well when supplied with either nitrate or ammonium nitrogen. With the exeption of crops such as paddy rice, most agriculturally important plants grown on well drained upland soils will absorb most of their nitrogen as nitrate. Nitrites are generally toxic to plants, but fortunately they do not accumulate under most soil conditions. The protein in the vegetative cells of plants is largely functional rather than structural in nature. Many of these proteins as enzymes still others are nucleoproteins protein serve as catalysts and as directors of metabolism. Functional proteins are not stable entities, for they are continually being broken down and reformed.

- Phosphorus. Phosphorus, with nitrogen and potassium, is classed as a major nutrient element. It occurs in most plants, however, in quantities that are much smaller than those of nitrogen and potassium. A good supply of phosphorus has been associated historically with increased root growth, several other gross quantitative effects on plant growth are atributed to phosphate fertilization. A good supply of phosphorus to hasten plant maturity and the other one frequently made of grain crops fertilized with ever greater quantities of phosphate fertilizer is the shorter period required for ripening the grain on those plots receiving the higher rates of phosphate.
- Potassium. Potassium as major element required for plant growth, its absorbed as the potassium ion K+ and is found in soils in varying amounts, but the fraction of the total potassium in the exchangeable or plant available from is usually small. Fertilizer potassium is added to soils in the form of such soluble salts as potassium chloride, potassium sulfate, potassium nitrate, and potassium-magnesium sulfate. Plant requirement for this element are quite high, when potassium is present in short supply, characteristic deficiency symptoms appear in the plant. Unlike nitogen, sulfur, phosporus, and several others, potassium apparently does not form an integral part of such plant components as protoplasm, fats, and cellulose. Its function appears

rather to be catalytic in nature. Despite this fact, it is nonetheless essential to the following physiological functions; (1) carbohydrate metabolism or formation and breakdown and translocation of starch, (2) nitrogen metabolism and synthesis of proteins, (3) control and regulation of activities of various essential mineral elements, (4) netralization of physiologically important organic acids, (5) activation of various enzymes, (6) promotion of the growth of meristematic tissues, and (7) adjusment of stomatal movement and water relations. Several effects potassium deficiencies are; development of the leaf characteristic, greatly reduce crop yields, infact, serious yield reductions may result without an exibition of deficiency symptoms, associated with a decrease in resistance to certain plant diseases, the quality of some crops particularly fruits and vegetables is decreased with low supplies of potassium, the photosynthesis is decreased with insufficient potassium whereas at the same time respiration may be increased this seriously reduce the supply of carbohydrates and consequently the growth of the plant, the last important effect of potassium on plant metabolism to be considered its relation to protein synthesis.

- Calcium. Calcium is an element required by all higher plants, absorbed as the ion Ca^2+, it is found in abundants quantities in the leaves of plants, in plants cells precipitated as calcium oxalate. It may also occure in the ionic from in cell sap. Calcium related to protein synthesis by its enchancement of the uptake of nitrate nitrogen and is associated with the activity of certain enzyme systems. The deficiencies of calcium manifest itself in the failure of the terminal buds of plants to develop, the same applies to the apical tips of roots as a result of these two phenomena, plant growth ceases in the absence of an adequate supply. It has also been suggested that calcium favors the formation of aand increases the protein content of mitochondria, if this is so, the role played by the mitochondria in aerobic respiration, hence salt uptake, indicates that there may be a direct relationship between calcium and ion uptake in general.

- Magnesium. Magnesium is absorbed in the form of the ion Mg^2+, it is the mineral constituent of the chlorophyll molecule and is located at its center, as described in the section on nitrogen. Magnesium is mobile element and is readily translocated from older to younger plant parts in the even of a deficiency, consequently the symptom often appears first on the lower leaves. In many species the deficiency results in an interveinal chlorosis of the leaf, in which only the vein remain green. In more advanced stages the leaf tissue becames uniformly pale yellow, then brown and necrotic. Magnesium is required for the activation of many enzymes concerned with carbohydrate metabolism and is prominent in the so-called citric acid cycle which is important to cell respiration.
- Sulfur. Sulfur is absorbed by plant roots almost exclusively as the sulfate ion SO_4^2-. Small amounts are absorbed as sulfur dioxide (SO_2) through plant leaves and are utilized by the plant, sulfur dioxid in anything but vry small concentrations, however is quite toxic. A deficiency of sulfur, which has a pronounced retarding effect on plant growth is characterized by uniformly chlorotic plants stunted, thin-stemmed, and spindly. The specific function of sulfur in plant growth and metabolism are numerous and important; (1) it is required for the synthesis of the sulfur containing amino acid, cystine, cysteine, and methonine, and for protein synthesis, (2) it activates certain

proteolytic enzymes, (3) it is a constituent of certain vitamins of coenzyme A, and of glutathione, (4) it is present in the oils of plants of the mustard and onion families, and (5) increases the oil content of crops such as soybeans.

6.4. Impact on Health of Animals

Non target organisms include all plants and animals in or near a treated area that are not intended to be controlled by pesticide application. Some types of pesticides have drastic effect on the environment including air, soil, water and large variety of living organisms. Not all the pesticide that the sprayed in a given location actually remains in that area. It is estimated that as much as 55% of the applied pesticide may leave the treated area due to spray drift, volatilization, leaching, run-off, and soil erosion. Some of this drift may move to adjacent areas and contaminate residence, water bodies, other crops, forest trees, and wildlife.

In land bodies of water such as ground water, surface water (lakes, stream, reservoirs and estuaries) are, unlike the open seas and oceans, relatively small captive sinks of the by-products of man's activities. Thus, they are especially vulnerable to the accumulation of abnormal levels of nutrients, trace contaminants, pesticides, and other chemicals. Pesticides reach aquatic systems by direct application, sparay drift from ground or aerial spraying, atmospheris fallout (rain and duststroms), run-off from agriculture land, discharge of effluent from chemical factories, and from sewage.

As the progressive use of organic insecticides reached massive proportions in the past 40-50 years, it became incresingly evident that they were having detrimental effects on aquatic form of life, carried away by natural forces such as wind, rain, dustorms, the flow of rivers, and ocean currents, residues of pesticides began to appear everywhere on the globe from tropical forests to Antartic snows. The more stable insecticides, such as the organocholre compounds, slow in decomposing, were taking heavy tolls of many fish species, aquatic invertebrates, and a wide variety of nontarget organisms. A greater long-term threat was the gradual built up of organochlorine residues in fish, with the consequental hazard to humans who stand at the end of the food chain.

Once aquatic systems, pesticides must be either broken down to simpler, less toxic compounds, or remain in the medium, or move back into the atmosphere by volatilization and codistillation, in which case they recycle back to water bodies bay fallout due to wing, rain, and dustorms. The effects of pesticides pollution aquatic systems depend on chemical characteristic of the compound, its stability and persistence in water, its solubility, its potential for uptake and bioconcentration into aquatic organisms, and the physical characteristics of the ecosystem, such as size, form, and location. Such characteristics of pesticides that cause hazards to aquatic systems are shown in Table 6.5. The toxicities of various pesticides to several species of freshwater fish are shown in Table 6.6.

Table 6.5. Characteristics of pesticides that caouse hazards to aquatics systems

Characteristics	Pesticides			
	Organochlorine	Organophosphates	Carbamates	Herbicides
Toxixity of aquatic fauna	+++	++	++	+
Solubility	-	+	+	+++
Potential for uptake and bioconcentration	+++	+	+	++
Persistence in aquatic systems	+++	+	+	++
Heavy usage on or close to water	+++	+++	++	+++

Table 6.6. Comparatives (ppb) of fish families to insecticides

Fish	Organochlorines (ppb)		Organophosphates (ppm)		Carbamates (ppm)	
	DDT	Lindane	Methyl parathion	Malathion	Azinphos-methyl	Carbaryl
Salmonidae						
Rainbow trout	7	27	2.8	0.17	0.014	4.3
Brown trout	2	2	4.7	0.20	0.004	2.0
Coho salmon	4	41	5.3	0.10	0.017	0.8
Percidae						
Yellow perch	9	68	3.1	0.26	0.013	0.7
Centrarcidae						
Red-ear sunfish	5	83	5.2	0.17	0.052	11.2
Bluegill sunfish	8	68	5.7	0.10	0.022	6.8
Large-mouth bass	2	32	5.2	0.28	0.005	6.4
Ictaluridae						
Channel catfish	16	44	5.7	9.0	3.3	15.8
Black bullhead	5	64	6.6	12.9	3.5	20.0
Cyprinidae						
Goldfish	21	131	9.0	10.7	4.3	13.2
Fathead minnow	19	87	8.9	8.6	0.24	14.6
Carp	10	90	7.1	6.6	0.70	5.3

A principle function of potassium in animal metabolism is the production of bioelectric currents. Animal cell use a portion of the energy resulting from oxidative metabolism to keep potassium on the inside and sodium on the outside of cell membranes.

6.5. Impact on Health of Human Beings

Early in the 20th century, a German scientist named Fritz Haber figured out how to short circuit the nitrogen cycle by fixing nitrogen chemically at high temperatures and pressures, creating fertilizers that could be added directly to soil. This technology has spread rapidly over the past century, and along with the advent of new crop varieties, the use of synthetic nitrogen fertilizers has led to an enormous boom in agricultural productivity. This agricultural productivity has helped us to feed a rapidly growing world population, but the increase in nitrogen fixation has had some negative consequences as well. While the consequences are perhaps not as obvious as an increase in global temperatures or a hole in the ozone layer, they are just as serious and potentially harmful for humans and other organisms.

Not all of the nitrogen fertilizer applied to agricultural fields stays to nourish crops. Some is washed off of agricultural fields by rain or irrigation water, where it leaches into surface or ground water and can accumulate. In groundwater that is used as a drinking water source, excess nitrogen can lead to cancer in humans and respiratory distress in infants. The U.S. Environmental Protection Agency (EPA) has established a standard for nitrogen in drinking water of 10 mg per liter nitrate-N. Unfortunately, many systems (particularly in agricultural areas) already exceed this level. By comparison, nitrate levels in waters that have not been altered by human activity are rarely greater than 1 mg/L. In surface waters, added nitrogen can lead to nutrient over-enrichment, particularly in coastal waters receiving the inflow from polluted rivers. This nutrient over-enrichment, also called eutrophication, has been blamed for increased frequencies of coastal fish-kill events, increased frequencies of harmful algal blooms, and species shifts within coastal ecosystems.

The real significance of the Non-Point Source pollution problem lies in the long-term ramifications on human health and the proper functioning of ecosystems. Throughout the world, ground and surface waters are the source of drinking and irrigation water. The protection of ground and surface water resources has became a primary global concern because of the public apprehension over long-term health efect resulting from drinking water containing low levels of toxic chemicals. A secondary concern is the accumulation of inorganic (e.g., salinity and trace elements) and organic chemical (e.g., pesticides) in soil that detrimentally impact agricultural productivity.

Reminiscent of the silent killer tobacco, which remained disassociated from its impact on human helat for decades due to inconclusive cause-and-effect evidence, the impact of NPS pollutans on human health is just beginning to be understood. Some chemicals (e.g., As, Cd, Pb, Hg, DDT and its degradation products, methoxychlor, triazine herbicides, synthetic pyrethroids, lindane, chlordane, dioxin and other) are suspected to disrupt the endocrine system, causing metabolic, neurogical, and immune system abnormalities (Colborn et.al, 1993). The hypothesis of Colborn et al. (1996) that certain NPS pollutants behave as endocrine disruptors, which may play a role in a range of problems from reproductive and development abnormalities to neurogical and immunological defeats to cancer, is beginning to be supported by evidence (Stillman, 1982; Colborn et al., 1993; Porterfield, 1994; Jacobson and Jacobson, 1996; Lipschutz, 1996; Repetto and Baliga, 1996; Topari et al., 1996). However, scientists are a long way from understanding at what levels of exposure these hormone-mimicking and blocking effects occure in wildlife, let alone humans (Guillette et al., 1995).

The impact of low-level contaminants is only now becoming apparent. Radionuclides, pesticides, solvents, heavy metals, and petroleum compounds are well known because of their association with hight-level point source pollution, but a new generation of carcinogens, mutagens, and teratogens is found to cycle from one medium or from to another. These include various classes of polychlorinated biphenyls (PCBs), furans, dioxins, and organochlorines. Whether consumed as residues in drinking water, in fruits and vegetables, or in the fat of fish and meat, these chemical pose potentially serious, long-term health risk.

Some common toxic chemicals and their associated maximum concentration levels (MCLs) are presented in Table 6.7. Maximum concentration levels have been determined by the U.S. Environmental Protection Agency (USEPA) to ensure protection against human carcinogenic or non-carcinogenic impacts resulting from chronic environmental chemical exposure.

Eutrophication. The nitrogen-rich compounds found in fertilizer run-off is the primary cause of a serious depletion of oxygen in many parts of the ocean, especially in coastal zones; the resulting lack of dissolved oxygen is greatly reducing the ability of these areas to sustain oceanic fauna. Visually, water may become cloudy and discolored (green, yellow, brown, or red).

High application rates of inorganic nitrogen fertilizers in order to maximize crop yields, combined with the high solubilities of these fertilizers leads to increased runoff into surface water as well as leaching into groundwater. The use of ammonium nitrate in inorganic fertilizers is particularly damaging, as plants absorb ammonium ions preferentially over nitrate ions, while excess nitrate ions which are not absorbed dissolve (by rain or irrigation) into runoff or groundwater.

Table 6.7. Toxicological profiles for selected chemicals

Class	Contaminant	MCL[a] (μg/l)	Toxic	Neurotoxic	Carcinogenic[b]	Teratogenic	Mutagenic
Metals	Lead	15	√	√	E	√	-
	Arsenic	50	√	-	A	√	√
	Mercury	2	√	√	E	√	√
	Cadmium	5	-	-	D	√	-
	Chromium	100	√	-	D	√	√
Petroleum hydrocarbon	Benzene (BTEX)	5	-	-	A	√	√
	Toluene	1000	√	-	D	√	-
	Ethylene	-	-	-	E	-	-
	Xylene	10000	√	√	D	√	-
	Hexachorobenzene	1	-	-	B	-	-
Chlorinated organic solvents	Trichloroethylene (TCE)	5	√	√	B	√	-
	Perchloroethylene (PCE)	5	√	√	B	-	-
	Methylene chloride	5	√	√	B	-	-
	Chloroform	-	√	√	B	-	-
	Carbon tetrachloride (CTC)	5	√	√	B	√	-
	Vinyl chloride (VC)	2	√	√	A	√	√
	Trichlorophenol	-	√	-	B	-	√
Wood-preserving chemicals	Pentachlorophenol (PCP)	1	√	-	B	-	-
	Creosote	-	-	-	B	-	-
PCBs	Polychlorinated biphenyls	0.5	√	√	B	√	√
Dioxins	Dioxins	0.0005	√	√	B	√	√
Pesticides	DDT (dichlorodiphenyltrichloroethane)	-	-	-	B	√	√
	EDB (Ethylene dibromide)	0.05	-	-	B	√	-
	Chlordane	2	√	√	B	-	-
	Heptachlor	0.4	-	-	B	-	-
	Toxophene	3	√	√	B	-	√
	Lindane	0.2	-	-	B	-	-

[a] Maximum concentration levels (MCLs) for selected chemicals are taken from Fetter, 1993.
[b] EPA carcinogen Classification System: (A) human carcinogens, (B) probable human carcinogens, (C) possible human crcinogens, (D) not classifiable, and (E) noncarcinogenic to humans.

Source: Freeze, 2000

Blue Baby Syndrome, Nitrate levels above 10 mg/L (10 ppm) in groundwater can cause 'blue baby syndrome' (acquired methemoglobinemia), leading to hypoxia (which can lead to coma and death if not treated).

Soil acidification, Nitrogen-containing inorganic and organic fertilizers can cause soil acidification when added. This may lead to decreases in nutrient availability which may be offset by liming.

Persistent organic pollutants, toxic persistent organic pollutants (POPs), such as Dioxins, polychlorinated dibenzo-p-dioxins (PCDDs), and polychlorinated dibenzofurans (PCDFs) have been detected in agricultural fertilizers and soil amendments.

Uranium is another example of a contaminant often found in phosphate fertilizers (at levels from 7 to 100 pCi/g). Eventually these heavy metals can build up to unacceptable levels and build up in vegetable produce. Average annual intake of uranium by adults is estimated to be about 0.5 mg (500 μg) from ingestion of food and water and 0.6 μg from breathing air.

Steel industry wastes, recycled into fertilizers for their high levels of zinc (essential to plant growth), wastes can include the following toxic metals: lead arsenic, cadmium, chromium, and nickel. The most common toxic elements in this type of fertilizer are mercury, lead, and arsenic. Also, highly radioactive Polonium-210 contained in phosphate fertilizers is absorbed by the roots of plants and stored in its tissues; tobacco derived from plants fertilized by rock phosphates contains Polonium-210 which emits alpha radiation estimated to cause about 11,700 lung cancer deaths each year worldwide. For these reasons, it is recommended that nutrient budgeting, through careful observation and monitoring of crops, take place to mitigate the effects of excess fertilizer application.

6.6. Impact on Atmospheric Condition

Reactive nitrogen (like NO_3- and NH_4+) present in surface waters and soils, can also enter the atmosphere as the smog-component nitric oxide (NO) and the greenhouse gas nitrous oxide (N_2O). Eventually, this atmospheric nitrogen can be blown into nitrogen-sensitive terrestrial environments, causing long-term changes. Increases in atmospheric nitrogen deposition have also been blamed for more subtle shifts in dominant species and ecosystem function in some forest and grassland ecosystems. There is now some evidence that elevated levels of atmospheric N input from nearby industrial and agricultural development have paved the way for invasion by non-native plants. As noted earlier, NO is also a major factor in the formation of smog, which is known to cause respiratory illnesses like asthma in both children and adults.

The atmospheric effects, global methane concentrations (surface and atmospheric); note distinct plumes, Methane emissions from crop fields (notably rice paddy fields) are increased by the application of ammonium-based fertilizers; these emissions contribute greatly to global climate change as methane is a potent greenhouse gas.

Through the increasing use of nitrogen fertilizer, which is added at a rate of 1 billion tons per year presently to the already existing amount of reactive nitrogen, nitrous oxide (N_2O) has become the third most important greenhouse gas after carbon dioxide and methane. It has a global warming potential 296 times larger than an equal mass of carbon dioxide and it also contributes to stratospheric ozone depletion.

Storage and application of some nitrogen fertilizers in some weather or soil conditions can cause emissions of the potent greenhouse gas—nitrous oxide. Ammonia gas (NH_3) may be emitted following application of 'inorganic' fertilizers and/or manures and slurries.

The use of fertilizers on a global scale emits significant quantities of greenhouse gas into the atmosphere. Emissions come about through the use of:

- ✓ animal manures and urea, which release methane, nitrous oxide, ammonia, and carbon dioxide in varying quantities depending on their form (solid or liquid) and management (collection, storage, spreading).
- ✓ fertilizers that use nitric acid or ammonium bicarbonate, the production and application of which results in emissions of nitrogen oxides, nitrous oxide, ammonia and carbon dioxide into the atmosphere.

CHAPTER VII

Result and Discussion

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RESULT AND DISCUSSION

7.1. Stream Water Quality

The growing populations in many of developing countries have been predicted further to intensify agricultural production requirements and the use of mineral and organic fertilizers to increase crop yield. Furthermore, industrial activities will add to natural environment contamination. The impact on water chemistry of anthropogenic pollution from industrial and agricultural sources has concerned environmentalists and scientists for decades.

This study presents the water quality of the some rivers and streams in the Bangka Belitung Island. The objective was to characterize the chemical and physical properties of surface water of the geological environments and to determine the anthropogenic impacts on stream water quality.

Water quality standards have been established for all surface waters. Rivers and streams are rated in one of five classes. Class 1-Extra clean, Class 2-Very clean, Class 3-Medium clean and Class 4 Fairly. For each of the parameters as shown Table 7.1. below.

Table 7.1. Surface Water Classification Standards

Classification	Objective/Condition and Beneficial Usage
Class 1	Extra clean fresh surface water resources used for : (1) conservation not necessary pass through water treatment process require only ordinary process for pathogenic destruction (2) ecosystem conservation where basic organisms can breed naturally
Class 2	Very clean fresh surface water resources used for : (1) consumption which requires ordinary water treatment process before use (2) aquatic organism of conservation (3) fisheries (4) recreation
Class 3	Medium clean fresh surface water resources used for : (1) consumption, but passing through an ordinary treatment process before using (2) agriculture
Class 4	Fairly clean fresh surface water resources used for : (1) consumption, but requires special water treatment process before using (2) industry

Source : Notification of the National Environment Board.

According to the results of analysis of stream water quality Baturusa-cerucuk data recorded is presented in Table 4.1. and Table 4.2., the conclusion as follows:

1. River that has been sampled is done at five locations, namely: (1). Muntok River (2). Jering River (3) Jeruk River, (4) Gusung River in Bangka, and (5) Lenggang River in Belitung.
2. Water quality parameters measured were 19 parameters, namely: (1). Temperature, (2). TDS, (3). pH, (4). DO, (5). BOD_5, (6). COD, (7). Total Phosphate/PO_4, (8). Nitrate/NO_3-N, (9). Ammonia/NH_3, (10). Detergents, (11). Iron/Fe, (12). Lead/Pb, (13). Zinc/Zn, (14). Sulfide/H_2S, (15). Phenol, (16). Oils and Fats, (17). Copper/Cu, (18). Coliform, and (19). Colifecal.

3. According to the evaluation of water quality to water use Class 1 (water allocation can be used for drinking water, and or other uses that require the same water quality). Class 2 (water allocation can be used for infrastructure/ facilities recreational water, freshwater fish farming, livestock, water to irrigate crops, and or other designated that require the same water quality with the use) of PP 82/2001, there are 6 parameters that do not meet water requirements for Class 1 and Class 2, ie : pH, BOD, COD, DO; and Iron. and Class 3 (water allocation can be used as irrigation agriculture).
4. Even though in terms of bacteriological detection of colifecal, but relatively small levels of between 5–48 mg/l.This is an indication of residents waste (feces) are discharged into rivers. Likewise, the total coliform is still relatively small and still in accordance with the requirements, but the detection of total coliform is an indication of animal manure is discharged into rivers.

7.2. Agro Produce Quality

Agro produce of rice production in the Bangka Belitung Islands from year to year fluctuations are influenced by various factors, with the planting area on average for 10 years an area of 6,234 ha while the largest area planted in 2010 covering an area of 9,877 ha and lowest in 2002 an area of 4,497 Ha. While the average productivity since the year 2001-2010 amounted to 25.34 Q/ha with the highest productivity occurred in 2006 amounted to 28.75 Q/ha and lowest in 2002 amounted to 22.94 Q/ha.

Table 7.2. Surface Water Quality Standards

Parameter		Units	Standard Value for Class				Methods for Examination
			Class 1	Class 2	Class 3	Class 4	
Physical							
1.	Colour,Odour and Taste	-	n	n'	n'	n'	
2.	Temperature	°C	n	n'	n'	n'	Thermometer
Chemical							
3.	pH	-	n	5-9	5-9	5-9	Electrometric pH Meter
4.	Dissolved Oxygen (DO)[2/]	mg/l	n	6.0	4.0	2.0	Azide Modification
5.	BOD (5 days, 20°C)	mg/l	n	1.5	2.0	4.0	Azide Modification at 20°C , 5 day
6.	NO_3 -N	mg/l	n	-	5.0	-	Cadmium Reduction
7.	NH_3 -N	mg/l	n	-	0.5	-	Distillation Nesslerization
8.	Phenols	mg/l	n	-	0.005	-	Distillation,4-Amino antipyrene
9.	Copper (Cu)	mg/l	n	-	0.1	-	Atomic Absorption -Direct Aspiration
10.	Nickle (Ni)	mg/l	n	-	0.1	-	Atomic Absorption -Direct Aspiration
11.	Manganese (Mn)	mg/l	n	-	1.0	-	Atomic Absorption -Direct Aspiration
12.	Zinc (Zn)	mg/l	n	-	1.0	-	Atomic Absorption -Direct Aspiration
13.	Cadmium (Cd)	mg/l	n	-	0.005* 0.05**	-	Atomic Absorption -Direct Aspiration
14.	Chromium Hexavalent	mg/l	n	-	0.05	-	Atomic Absorption -Direct Aspiration
15.	Lead (Pb)	mg/l	n	-	0.05	-	Atomic Absorption -Direct Aspiration
16.	Total Mercury (Total Hg)	mg/l	n	-	0.002	-	Atomic Absorption-Cold Vapour Technique
17.	Arsenic (As)	mg/l	n	-	0.01	-	Atomic Absorption -Direct Aspiration
18.	Cyanide (Cyanide)	mg/l	n	-	0.005	-	Pyridine-Barbituric Acid
19.	Radioactivity (Alpha, Beta)	Becqurel/l	n	-	1.0	-	Gas-Chromatography
20.	Total Organochlorine Pesticides	mg/l	n	-	0.05	-	Gas-Chromatography
21.	DDT	µg/l	n	-	1.0	-	Gas-Chromatography
22.	Alpha-BHC	µg/l	n	-	0.02	-	Gas-Chromatography
23.	Dieldrin	µg/l	n	-	0.01	-	Gas-Chromatography
24.	Aldrin	µg/l	n	-	0.1	-	Gas-Chromatography
25.	Heptachlor & Heptachlorepoxide	µg/l	n	-	0.2	-	Gas-Chromatography
26.	Endrin	µg/l	n	-	None	-	Gas-Chromatography
Biological							
27.	Total Coliform Bacteria	MPN/100 ml	n	5,000	20,000	-	Multiple Tube Fermentation Technique
28.	Fecal Coliform Bacteria	MPN/100 ml	n	1,000	4,000	-	Multiple Tube Fermentation Technique

Remark : n : naturally, n' : naturally but changing not more than 3°C. *) : when water hardness not more than 100 mg/l as $CaCO_3$
**) : when water hardness more than 100 mg/l as $CaCO_3$

Source : Notification of the National Environmental Board, issued under the Enhancement and Conservation of National Env. Quality

The highest production occurred in 2010 amounting to 25,532.05 tonnes and the lowest in the year 2002 of 10,316.12 tonnes of this condition is the lowest production very significantly during the past 10 years caused by weather conditions that do not allow, with the average since the year 2001 to 2010 amounting to 17,941.72 tonnes. As shown in Table 7.3.

Increasing the quantity of production with the general quality from year to year because of the carrying capacity of production facilities and infrastructure are adequate, in addition to the use of synthetic fertilizer in recent years began to develop a natural fertilizer certainly in support of the green revolution, in an effort to minimize the impact on the environment.

Table 7.3. Agro produce quality and production of crops.

Year	Crops	Area (Ha)	Productivity (Q/Ha)	Production (Ton)	Quality
2001	Paddy	7,130	23.04	16,427.52	Good
2002	Paddy	4,497	22.94	10,316.12	Good
2003	Paddy	5,234	23.25	12,169.05	Good
2004	Paddy	7,402	25.35	18,764.07	Good
2005	Paddy	6,691	28.44	19,029.20	Good
2006	Paddy	5,741	28.75	16,505.38	Good
2007	Paddy	9,010	27.07	24,390.07	Good
2008	Paddy	6,266	24.06	15,076.00	Good
2009	Paddy	8,603	24.64	21,197.79	Good
2010	Paddy	9,877	25.85	25,532.05	Good
Average		**6,234**	**225.34**	**17,841.72**	

Source : Central Statistical Agency, (2010)

7.3. Human and Animal Health

Manure contamination bad for human and animal health, controlling animal wastes on the farm can improve both human and animal health. Water contaminated with manure contains more nutrients and becomes a vector for waterborne disease. Both can affect human and animal health.

7.3.1. Human Health

Avoiding contamination of water supplies is a must and proper treatment of surface water and shollow groundwater supplies is necessary to make water potable. Coagulation followed by different types of filtration are especially effective in removing parasites.

When in-house treatment is followed by a point-of-use membrane process for example, reverse osmosis or nanofiltration the likelihood of any parasites getting through into the finished water is very small. Good hygiene, effective in-house treatment and proper waste management will pay off in better health.

7.3.2. Animal Health

The best practice is to water animals from troughs or other watering devices isolated from animal wastes. Because phosphorus and nitrogen in manure are potent fertilizers for aquatic plants. Excessive alga and rooted aquatic plant growth produces oxygen by photosynthesis when the sun is shining. However, this growth soon becomes rotting biomass and its decomposition consumes oxygen so that only specially adapted creatures can survive. Also, the oxygen concentration falls and anaerobic conditions may form. This will kill fish and other aquatic organisms.

As well, some algae produce toxins that make the water unpalatable. As a result, animals will reduce their intake or become ill. This causes reduced production and profit loss. Allowing animal waste to contaminate water also makes disease transmission possible. The two most common parasites of cattle, sheep and pigs are *giardia* and *cryptosporidium.* These protozoan pathogens can also infect humans.

The prevalence of giardiasis or cryptosporidiosis in some. This can cause scours in calves and reduced weight gain. At the moment there is no effective vaccine and only giardiasis can be treated. Calves are most susceptible, but some older animals become carriers. Wild animals such as beaver and muskrat can also become infected, as can humans if they drink unfiltered water. *Giardia* and *cryptosporidium* are resistant to water treatment and simple chlorination will not kill them.

7.4. Climate Change

Climate change, physical, biological, social and agriculture are interrelated processes, both of which take place on a global scale. as shown in Figure 7.1.

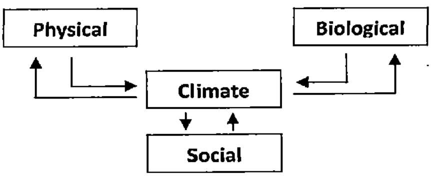

Figure 7.1. Climate relationship diagram

Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, carbon dioxide, glacial run-off, precipitation and the interaction of these elements as presensed in Figure 7.2.These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. The overall effect of climate change on agriculture will depend on the balance of these effects. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt farming to maximize agricultural production (Fraser, E. 2008. *Crop yield and climate change*).

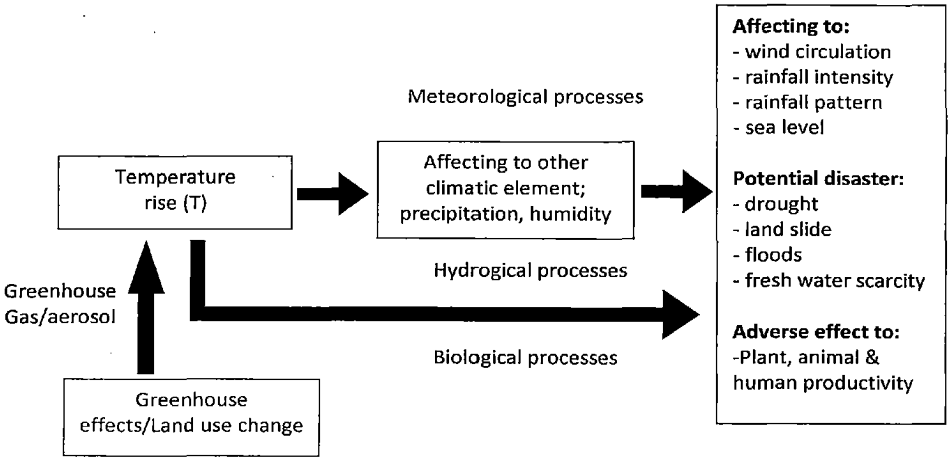

Figure 7.2. Global warming processes and climate change impacts.

At the same time, agriculture has been shown to produce significant effects on climate change, primarily through the production and release of greenhouse gases such as carbon dioxide, methane, and nitrous oxide, but also by altering the Earth's land cover, which can change its ability to absorb or reflect heat and light, thus contributing to radiative forcing. Land use change such as deforestation and desertification, together with use of fossil fuels, are the major anthropogenic sources of carbon dioxide; agriculture itself is the major contributor to increasing methane and nitrous oxide concentrations in earth's atmosphere.

7.4.1. Impact of climate change on agriculture

Despite technological advances, such as improved varieties, genetically modified organisms, and irrigation systems, weather is still a key factor in agricultural productivity, as well as soil properties and natural communities. The effect of climate on agriculture is related to variabilities in local climates rather than in global climate patterns. The Earth's average surface temperature has increased by 1°F in just over the last century. Consequently, agronomists consider any assessment has to be individually consider each local area.

On the other hand, agricultural trade has grown in recent years, and now provides significant amounts of food, on a national level to major importing countries, as well as comfortable income to exporting ones. The international aspect of trade and security in terms of food implies the need to also consider the effects of climate change on a global scale.

More favourable effects on yield tend to depend to a large extent on realization of the potentially beneficial effects of carbon dioxide on crop growth and increase of efficiency in water use. Decrease in potential yields is likely to be caused by shortening of the growing period, decrease in water availability and poor vernalization (the acquisition of a plant's ability to flower orgerminate in the spring by exposure to the prolonged cold of winter, after vernalization, plants have acquired the ability to flower). In the long run, the climatic change could affect agriculture in several ways :

- *productivity*, in terms of quantity and quality of crops
- *agricultural practices*, through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers
- *environmental effects*, in particular in relation of frequency and intensity of soil drainage(leading to nitrogen leaching), soil erosion, reduction of crop diversity
- *rural space*, through the loss and gain of cultivated lands, land speculation, land renunciation, and hydraulic amenities.
- *adaptation*, organisms may become more or less competitive, as well as humans may develop urgency to develop more competitive organisms, such as flood resistant or salt resistant varieties of rice.

They are large uncertainties to uncover, particularly because there is lack of information on many specific local regions, and include the uncertainties on magnitude of climate change, the effects of technological changes on productivity, global food demands, and the numerous possibilities of adaptation.

The agricultural production will be mostly affected by the severity and pace of climate change, not so much by gradual trends in climate. If change is gradual, there may be enough time for biota adjustment. Rapid climate change, however, could harm agriculture in many countries, especially those that are already suffering from rather poor soil and climate conditions, because there is less time for optimum natural selection and adaption.

7.4.1.1. Poverty impacts

The potential impacts climate change could have on agriculture, and how this would affect attempts at alleviating poverty in the developing world (Overseas Development Institute. 2007. "Climate change, agricultural policy and poverty). They argued that the effects from moderate climate change are likely to be mixed for developing countries. However, the vulnerability of the poor in developing countries to short term impacts from climate change, notably the increased frequency and severity of adverse weather events is likely to have a negative impact. This, they say, should be taken into account when defining agricultural policy.

7.4.1.2. Crop development models

Models for climate behavior are frequently inconclusive. In order to further study effects of global warming on agriculture, other types of models, such as *crop development models*, *yield prediction*, quantities of *water or fertilizer consumed*, can be used. Such models condense the knowledge accumulated of the climate, soil, and effects observed of the results of various agricultural practices.

They thus could make it possible to test strategies of adaptation to modifications of the environment. Because these models are necessarily simplifying natural conditions (often based on the assumption that weeds, disease and insect pests are controlled), it is not clear whether the results they give will have an *in-field* reality. However, some results are partly validated with an increasing number of experimental results.

Scenarios are used in order to estimate climate changes effects on crop development and yield. Each scenario is defined as a set of meteorological variables. For example, many models are running simulations based on doubled carbon dioxide projections, temperatures raise ranging from 1°C up to 5°C, and with rainfall levels an increase or decrease of 20%. Other parameters may include humidity, wind, and solar activity. Scenarios of crop models are testing farm-level adaptation, such as sowing date shift, climate adapted species (vernalisation need, heat and cold resistance), irrigation and fertilizer adaptation, resistance to disease.

7.4.1.3. Temperature potential effect on growing period

Duration of crop growth cycles are above all, related to temperature. An increase in temperature will speed up development. In the case of an annual crop, the duration between sowing and harvesting will shorten (for example, the duration in order to harvest corn could shorten between one and four weeks). The shortening of such a cycle could have an adverse effect on productivity because senescence (the change in the biology of an organism as it ages after its maturity. Such changes range from those affecting its cells and their function to that of the whole organism) would occur sooner.

7.4.1.4. Effect of elevated carbon dioxide on crops

Carbon dioxide is essential to plant growth. Rising CO_2 concentration in the atmosphere can have both positive and negative consequences. Increased CO_2 is expected to have positive physiological effects by increasing the rate of photosynthesis. Currently, the amount of carbon dioxide in the atmosphere is 380 parts per million. In comparison, the amount of oxygen is 210,000 ppm. This means that often plants may be starved of carbon dioxide, due to the enzyme that fixes CO_2, rubisco also fixes oxygen in the process of photorespiration.

The effects of an increase in carbon dioxide would be higher on C3 crops (such as wheat) than on C4 crops (such as maize), because the former is more susceptible to carbon dioxide shortage. Studies have shown that increased CO_2 leads to fewer stomata developing on plants which leads to reduced water usage (Bert G. Drake; Gonzalez-Meler, Miquel A., Long, Steve P., 1997, "More efficient plants: A Consequence of Rising Atmospheric CO_2". *Annual Review of Plant Physiology and Plant Molecular Biology* 48:609). Under optimum conditions of temperature and humidity, the yield increase could reach 36%, if the levels of carbon dioxide are doubled.

Further, few studies have looked at the impact of elevated carbon dioxide concentrations on whole farming systems. Most models study the relationship between CO_2 and productivity in isolation from other factors associated with climate change, such as an increased frequency of extreme weather events, seasonal shifts, and so on.

7.4.1.5. Effect on quality

According to the IPCC TAR (Intergovernmental Panel on Climate Change Third Assessment Report), "The importance of climate change impacts on grain and forage quality emerges from new research. For rice, the amylose content of the grain --a major determinant of cooking quality-- is increased under elevated CO_2" (Conroy et al., 1994). Cooked rice grain from plants grown in high-CO_2 environments would be firmer than that from today's plants. However, concentrations of iron and zinc, which are important for human nutrition, would be lower (Seneweera and Conroy, 1997). Moreover, the protein content of the grain decreases under combined increases of temperature and CO_2 (Ziska et al., 1997).

Studies have shown that higher CO_2 levels lead to reduced plant uptake of nitrogen (and a smaller number showing the same for trace elements such as zinc) resulting in crops with lower nutritional value. This would primarily impact on populations in poorer countries less able to compensate by eating more food, more varied diets, or possibly taking supplements. Reduced nitrogen content in grazing plants has also been shown to reduce animal productivity in sheep, which depend on microbes in their gut to digest plants, which in turn depend on nitrogen intake (Scherer, Glenn Grist, 2005).

7.4.1.6. Agricultural surfaces and climate changes

Climate change may increase the amount of arable land (land that can be used for growing crops. It includes not only cultivated land, but also the totality of all land where soil and climate is suitable for agriculture), in high-latitude region by reduction of the amount of frozen lands.

Sea levels are expected to get up to one meter higher by 2100, though this projection is disputed. A rise in the sea level would result in an agricultural land loss, in particular in areas such as South East Asia. Erosion, submergence of shorelines, salinity of the water table due to the increased sea levels, could mainly affect agriculture through inundation of low-lying lands.

7.4.1.7. Erosion and fertility

The warmer atmospheric temperatures observed over the past decades are expected to lead to a more vigorous hydrological cycle, including more extreme rainfall events. Erosion and soil degradation is more likely to occur.

Soil fertility would also be affected by global warming. However, because the ratio of carbon to nitrogen is a constant, a doubling of carbon is likely to imply a higher storage of nitrogen in soils as nitrates, thus providing higher fertilizing elements for plants, providing better yields. The average needs for nitrogen could decrease, and give the opportunity of changing often costly fertilisation strategies.

Due to the extremes of climate that would result, the increase in precipitations would probably result in greater risks of erosion, whilst at the same time providing soil with better hydration, according to the intensity of the rain. The possible evolution of the organic matter in the soil is a highly contested issue: while the increase in the temperature would induce a greater rate in the production of minerals, lessening the soil organic matter content, the atmospheric CO_2 concentration would tend to increase it.

7.4.1.8. Potential effects of global climate change on pests, diseases and weeds

A very important point to consider is that weeds would undergo the same acceleration of cycle as cultivated crops, and would also benefit from carbonaceous fertilization. However, on the other hand, some results make it possible to think that weedkillers could gain in effectiveness with the temperature increase.

Global warming would cause an increase in rainfall in some areas, which would lead to an increase of atmospheric humidity and the duration of the wet seasons. Combined with higher temperatures, these could favor the development of fungal diseases. Similarly, because of higher temperatures and humidity, there could be an increased pressure from insects and disease vectors.

7.4.1.9. Ozone and UV-B

Some scientists think agriculture could be affected by any decrease in stratospheric ozone, which could increase biologically dangerous ultraviolet radiation B. Excess ultraviolet radiation B can directly effect plant physiology and cause massive amounts of mutations, and indirectly through changed pollinator (the biotic agent/vector that moves pollen from the male anthers of a flower to the female stigma of a flower to accomplish fertilization) behavior, though such changes are simple to quantify (*Brown, Paul*, 2005, Ozone layer least fragile on record). However, it has not yet been ascertained whether an increase in greenhouse gases would decrease stratospheric ozone levels.

In addition, a possible effect of rising temperatures is significantly higher levels of ground-level ozone, which would substantially lower yields.

7.4.1.10. ENSO effects on agriculture

ENSO (El Niño Southern Oscillation) will affect monsoon patterns more intensely in the future as climate change warms up the ocean's water. Crops that lie on the equatorial belt or under the tropical Walker circulation, such as rice, will be affected by varying monsoon patterns and more unpredictable weather. Scheduled planting and harvesting based on weather patterns will become less effective.

Areas such as Indonesia where the main crop consists of rice will be more vulnerable to the increased intensity of ENSO effects in the future of climate change and 20 different logistical models mapping out climate factors such as wind pressure, sea-level, and humidity, and found that rice harvest will experience a decrease in yield. Bali and Java, which holds 55% of the rice yields in

Indonesia, will be likely to experience 9-10% probably of delayed monsoon patterns, which prolongs the hungry season. Normal planting of rice crops begin in October and harevest by January. However, as climate change affects ENSO and consequently delays planting, harvesting will be late and in drier conditions, resulting in less potential yields (Battisti, David S. et al., 2007, Assessing risks of climate variability and climate change for Indonesian rice agriculture. Proceedings of the National Academy of Sciences of the United States of America. No.19 : 7752-7757).

7.4.2. Impact of agriculture on climate change

The agricultural sector is a driving force in the gas emissions and land use effects thought to cause climate change. In addition to being a significant user of land and consumer of fossil fuel, agriculture contributes directly to greenhouse gas emissions through practices such as rice production and the raising of livestock according to the Intergovernmental Panel on Climate Change, the three main causes of the increase in greenhouse gases observed over the past 250 years have been fossil fuels, land use, and agriculture.

7.4.2.1. Land use

Agriculture contributes to greenhouse gas increases through land use in four main ways:

- CO_2 releases linked to deforestation
- Methane releases from rice cultivation
- Methane releases from enteric fermentation in cattle
- Nitrous oxide releases from fertilizer application

Together, these agricultural processes comprise 54% of methane emissions, roughly 80% of nitrous oxide emissions, and virtually all carbon dioxide emissions tied to land use. The planet's major changes to land cover since 1750 have resulted from deforestation in temperate regions: when forests and woodlands are cleared to make room for fields and pastures (land with vegetation cover used for grazing of livestock as part of a farm), the albedo (defined as the ratio of reflected radiation from the surface to incident radiation upon it) of the affected area increases, which can result in either warming or cooling effects, depending on local conditions. Deforestation also affects regional carbon reuptake, which can result in increased concentrations of CO_2, the dominant greenhouse gas. Land-clearing methods such as slash and burn compound these effects by burning biomatter, which directly releases greenhouse gases and particulate matter such as soot (impure carbon particles resulting from the incomplete combustion of a hydrocarbon) into the air.

7.4.2.2. Livestock

Livestock and livestock-related activities such as deforestation and increasingly fuel-intensive farming practices are responsible for over 18% of human-made greenhouse gas emissions (FAO, 2007), including:

- 9% of global carbon dioxide emissions,
- 35-40% of global methane emissions (chiefly due to enteric fermentation and manure),
- 64% of global nitrous oxide emissions (chiefly due to fertilizer use).

Livestock activities also contribute disproportionately to land-use effects, since crops such as corn and alfalfa are cultivated in order to feed the animals. Worldwide, livestock production occupies 70% of all land used for agriculture, or 30% of the land surface of the Earth.

CHAPTER VIII

Summary and Conclusion

CHAPTER VIII

SUMMARY AND CONCLUSION

8.1. Summary

An important issue is the degradation of water quality from nonpoint sources of pollution, including the prevalent use of fertilizers and pesticides on agricultural land. The issue is of interest to many residents, water resource managers, and policymakers across the nation because of the possible impacts on water uses, such as drinking, irrigation, recreation, and sustaining aquatic life.

In sufficient quantities, nutrients from fertilizers encourage abundant growth of algae, which leads to low oxygen in streams and the possibility of fish killing. Pesticides and nitrate are a potential concern for human health if they affect a drinking water source or occur where there is recreational use. Elevated concentrations of nitrate have been associated with *methemoglobinemia,* or "blue baby syndrome" in infants, and stomach disorders, and some pesticides have been associated with the potential for causing cancer.

Water contamination in agricultural areas is not, however, determined solely by chemical use. Natural features —topography, geology, soil type, hydrology, climate and land-management practices— tile drainage and irrigation and conservation strategies make some areas more vulnerable to contamination than others. Although the sampling of nitrogen and phosphorus, indicated that streams and in agricultural basins almost always contain complex mixtures of nutrients and pesticides. Concentrations of nitrogen and phosphorus in streams can contribute to excessive plant growth.

Pesticides Impacts

Fertilizers and pesticides both have definite pros and cons associated with their use. Both types of chemical tend to increase yields, and thus make a significant difference in food production, particularly in countries that struggle periodically with famines. On the other hand, they both can cause water pollution when erosion carries the chemicals off of farms along with eroded soils after each rainfall.

Positive Impacts of Pesticides

1. According to the National Institute of Environmental Health Sciences, the term pesticide includes chemicals used to control insects, fungi and weeds. Pesticides serve many functions, some of which are more essential to society than others. Pesticides can prevent crop failure, control invasive plants, or promote a uniformly green lawn. Some pesticides reduce blemishes on fruit and vegetables, ensuring that a greater proportion of the crop is marketable.
2. Farmers use chemical pesticides to eliminate insects and diseases that destroy crops and diminish food supply. These compounds work very well in killing the insects that feed on the roots, leaves and stems of both food crops and garden flowers. Using these pesticides saves the crops that feed nations all around the world. They can often mean the difference between a healthy, expanding population and malnutrition and death.

Negative Impacts of Pesticides

1. **Organophosphates**; Disturb of the central nervous system (brain) and peripheral nervous system (nerves found outside of the brain or spinal cord).

Organophosphates attach themselves to the enzyme (acetylcholinesterase-AChE) that stops nerve transmission. Therefore, there is suppression of AChE and continuous electrical nerve transmission. This particularly affects the muscles, glands and smooth muscles that make the body organs function. *General central nervous system*: Fatigue, Dizziness, Headache, Hand tremors, Staggering gait, Convulsions, Loss of consciousness, and Coma. *From muscle over stimulation*: Muscle weakness, Muscle cramps, and Twitching eyelids. *From gland over stimulation:* Salivary gland- excessive salivation, Sweat gland- excessive sweating, and Lacrimal gland-excessive eye tearing. *From organ over-stimulation*: Eyes ; Blurred vision (constricted pupils), Gastrointestinal; Stomach cramps, Nausea, Vomiting, Diarrhea, Pulmonary (Lungs); Chest tightness, Wheezing, Cough, and Runny nose.

2. **Carbamates**; Carbamates behave the same way as the organophosphates in that they suppress AChE, and cause over-stimulation of the nerves. The effect comes on sooner after exposure (as fast as 15 minutes) and does not last as long (3 hours). Symptoms are the same with the exception of these symptoms below which are rare: Convulsions, Loss of consciousness, and Coma.
3. **Organochlorines**; Disturb the central nervous system. They are absorbed by fat so they can stay in the body a long time. As the fats cells in breast tissue can store organochlorines, it can measured in breast milk. The effects can occur within one hour after absorption and acute effects can last up to 48 hours. Some organochlorines (endosulfan) are rapidly and easily absorbed through the skin. *The nerves stimulating glands are not affected will not see*: excessive salivation, excessive sweating, excessive eye tearing, over-stimulation of small muscles like twitching eyelids. *That are from disruption*

of central nervous:Muscle Weakness, Dizziness, Headache, Numbness, Nausea, Loss of consciousness, Convulsions, Vomiting,Hand tremors, Staggering gait, Anxiety/restlessness, and Confusion.

4. **Pyrethroids**; Pyrethroids are irritants to the eyes, skin and respiratory tract. The symptoms last from 1-2 hours. The symptoms from spraying can be; *Normal use*; Numbness (hypersensitivity of skin), Shortness of breath (wheezing), Dry throat, Sore Throat, Burning nose, and skin itching. *If ingested*; Loss of consciousness/coma, and Convulsions. *High doses*; Vomiting, Diarrhea, Excessive saliva, Twitching eyelids, Staggering gait, and Irritability.

5. **Thiocarbamates**; Thiocarbamates are similar to the pyrethroids in that they also are irritants to the eyes, skin and respiratory tract. The symptoms can appear immediately when spraying and can be: *Respiratory tract*; Dry throat, Sore Throat, Burning nose, and Cough. *Eyes*; Eye irritation (burning, itching), and Red eyes. *Skin*; Skin itching, White spots on skin, Scaling skin rash, and Red rash.

6. **Paraquat**; Paraquat is very toxic to the skin and mucous membranes (inside of mouth, nose, eyes). Particles are too large to get deep into the lungs (manufacturer claims), but once paraquat is in the blood it collects in the lungs. If ingested (drink) it is very lethal. Symptoms can be:*Skin*; dryness, cracks, erythema (redness), blistering, and ulcerations. *Nails*; discoloration, splitting nails, and loss of nails. *Respiratory tract;* cough, nosebleeds, and sore throat. *Eyes;* conjunctivitis (irritation), ulceration, scarring, and blindness. *Ingestion;* lung fibrosis (stiff lungs), multi-system organ failure, specifically respiratory failure, and kidney failure.

7. **High nitrate contamination**; Blue baby syndrome can also be caused by Methemoglobinemia. It is believed to be caused by high nitrate contamination in ground water resulting in *decreased oxygen carrying capacity of hemoglobin* in babies leading to death. The groundwater is thought to be contaminated by leaching of nitrate generated from fertilizer used in agricultural lands and waste dumps. It may also be related to some pesticides (DDT, PCBs etc), which cause ecotoxicological problems in the food chains of living organisms, increasing BOD, which kills aquatic animals.

Fertilizer impacts

As fertilizer contains both nitrogen and phosphorus, it can cause negative effects on the environment. Rainwater acts as a vehicle for carrying fertilizer from the place of application and depositing it as a pollutant into rivers and lakes, ultimately contaminating both the ground and air. The impacts of fertilizer mentioned as follows.

Positive Impacts of Fertilizers

There is no doubt that fertilizers increase yields of crops around the world. Use of modern fertilizers exploded after World War II. New, ammonia-based fertilizers also fed the process of specialization that was occurring in agriculture. Farmers rotated crops less, which led more quickly to soil exhaustion. Norman Borlaug, the father of the 1960s Green Revolution, which vastly expanded food production and helped stave off world hunger, has argued that modern farming, including the use of fertilizers and herbicides, could "double or triple food production". Increased yields also reduce the need for conversion of wild lands to agriculture, contributing to the conservation of biodiversity.

Negative Impacts of Fertilizers

1. **Trace mineral depletion**; Many inorganic fertilizers may not replace trace mineral elements in the soil which become gradually depleted by crops.
2. **Fertilizer burn**; Over-fertilization of a vital nutrient can be as detrimental as underfertilization. "Fertilizer burn" can occur when too much fertilizer is applied, resulting in a drying out of the roots and damage or even death of the plant.
3. **High energy consumption**; The production of synthetic ammonia currently consumes about 5% of global natural gas consumption, which is somewhat under 2% of world energy production. Natural gas is overwhelmingly used for the production of ammonia, but other energy sources, together with a hydrogen source, can be used for the production of nitrogen compounds suitable for fertilizers. The cost of natural gas makes up about 90% of the cost of producing ammonia. The increase in price of natural gases over the past decade, along with other factors such as increasing demand, have contributed to an increase in fertilizer price.
4. **Long-Term Sustainability**; Inorganic fertilizers are now produced in ways which theoretically cannot be continued indefinitely. Potassium and phosphorus come from mines (or saline lakes such as the Dead Sea) and such resources are limited. More effective fertilizer utilization practices may, however, decrease present usage from mines. Improved knowledge of crop production practices can potentially decrease fertilizer usage of P and K without reducing the critical need to improve and increase crop yields. Atmospheric (unfixed) nitrogen is effectively unlimited (forming over 70% of

the atmospheric gases), but this is not in a form useful to plants. To make nitrogen accessible to plants requires nitrogen fixation (conversion of atmospheric nitrogen to a plant-accessible form.

5. **Eutrophication**; The nitrogen-rich compounds found in fertilizer run-off is the primary cause of a serious depletion of oxygen in many parts of the ocean, especially in coastal zones; the resulting lack of dissolved oxygen is greatly reducing the ability of these areas to sustain oceanic fauna. Visually, water may become cloudy and discolored (green, yellow, brown, or red).

6. **Blue Baby Syndrome;** Nitrate levels above 10 mg/L (10 ppm) in groundwater can cause 'blue baby syndrome' (acquired methemoglobinemia), leading to hypoxia (which can lead to coma and death if not treated).

7. **Soil acidification;** Nitrogen-containing inorganic and organic fertilizers can cause soil acidification when added. This may lead to decreases in nutrient availability which may be offset by liming.

8. **Atmospheric effects;** Methane emissions from crop fields (notably rice paddy fields) are increased by the application of ammonium-based fertilizers; these emissions contribute greatly to global climate change as methane is a potent greenhouse gas.

9. **Increased pest health;** Excessive nitrogen fertilizer applications can also lead to pest problems by increasing the birth rate, longevity and overall fitness of certain agricultural pests.

10. **Crop Absorption**; Often, crops cannot absorb all the nutrients from fertilizer, forcing the excess into the air and water. This loss also affects farmers' profitability as they spend more and more on fertilizer.
11. **Water**; The presence of nitrogen fertilizers in water encourages algae blooms, both toxic and non-toxic, which deplete oxygen and reduce light penetration in water. This in turn promotes the growth of weeds and negatively affects aquatic life.
12. **Dead Zones**; When algae populations get too large, their resulting death reduces oxygen in the water, suffocates fish and creates dead zones in the oceans.
13. **Drinking Water**; Nitrogen in fertilizer filters into groundwater, thus ending up in drinking water. In the human body, nitrogen becomes nitrate, which inhibits the movement of oxygen through the body.
14. **Greenhouse Gases**; Unabsorbed nitrogen from fertilizer can also leach into the air, contributing to greenhouse gases and air pollution.

8.2. Conclusion

The efficiency of fertilizer application, the criteria of harvests dependence on the level of soil cultivation, as well as the best indicators of soil fertility were calculated on the basis of sample research. The samples collected contained identical or very similar doses of fertilizers. In such calculations, the interaction of climate, soil conditions and mineral fertilizers was not taken into account. The proposed approach refines the patterns of the formation of grain yield on the level of individual agricultural enterprises. It also gives a possibility to forecast the effectiveness of the use of mineral fertilizers, while including into the normative calculations a paramount factor of weather conditions.

Pesticides are a revolutionary product that is not only interesting but also terrifying. Dealing with pesticide use, natural environment polluted. If not used pests and diseases a scourge to mankind. This is called tragedy and people who deal with the tragedy could take action and steps that will fit the demands of the situation.

If pesticides are used within the bounds of reasonableness in accordance with instructions for use may be an action that could minimize the scope of the risks to be borne human and nature. Use of pesticides blindly could invite disaster. Therefore, pesticide issues demanding the attention of all parties, not just the officials, not only the service users. We all bear collective responsibility for our own environment. Pesticides are not only the responsibility of producing factories, and responsibilities of government that gives the production license, but also responsibility of all parties, all peoples and all nations.

If in a country of a type of pesticide has been investigated, declared dangerous, and forbidden to be used, should all countries in the world also have to understand it and participate. Use of pesticides banned but still produced and even exported to neighboring countries.

Every effort eradication must involve all parties and be thorough, if expected to succeed. Hopefully in future cases resulting from the use or production of pesticides started to shrink or even disappear altogether. Although difficult, we are all striving for a risk to the environment was increasingly reduced.

8.3. Recommendations

The recommendation for the control of sediment, fertilizer and pesticide impacts on water resources have been enumerated in each respective chapter. In this concluding chapter are discussed a selection of issues pertaining to water quality which have over-arching implications for agriculture.

1. The environmental impacts on water resources [in general] caused by agricultural activities cannot be disassociated from the agricultural impacts in production areas themselves. They require monitoring, and preventive measures should always be systemically integrated.
2. It is necessary to develop and implement water resource monitoring systems with a prior definition of indicators, parameters, tolerance limits, frequency and sampling points, combining this information with quantity data.
3. Data and information generated should be properly treated in the sense of disseminating them as much as possible in order to heighten awareness and mobilization of the public sector and of society with respect to agriculture's impact on the environment.
4. Attempts should be made to exchange information and to pursue horizontal cooperation among countries, in order to promote the exchange of information and experiences.
5. In the prevention systems proposed, solutions to causes should be looked for, seeking to match the agricultural model to the socio-economic needs of the population within environmental limits and vocations.
6. Besides treating water quality related problems, there is evidence of other problems generated by conflicts in use, particularly the need to integrate

quality management with the quantity of water within a comprehensive, decentralized and participatory management system, reconciling regional development with environmental protection.

7. The cooperation of fiscalizing and monitoring agencies dealing with agrotoxic substances is urgent, with the capacity for control structures, seeking the development of biological indicators (enzymes, AMES test, biotesting, bioindicators) of residues and of anatomy and pathological damages caused by agrotoxic substances.

8. Slow-Release Fertilizer for Steady Growth and Water Quality Protection, Slow-release fertilizers are recommended for all varieties, a slow-release fertilizer will promote steady, uniform growth and help protect water quality while providing the nitrogen (and other nutrients) necessary for healthy and growth.

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APPENDICES

Appendix 1

USEFUL INTERNET SITES

INTERNATIONAL PROGRAMMES

Programme	Web site
Global Energy and Water Cycle Experiment (GEWEX)	http://www.gewex.com/
International Geosphere Biosphere Programme	http://www.igbp.kva.se/
World Climate Programme	http://www.wmo.ch/

RELATED INTERNATIONAL BODIES

Organization	Web site
Environmental Investigation Agency (EIA)	http://www.eia-international.org/
International Association on Water Quality (IAWQ)	http://www.iawq.org.uk/
International Commision on Irrigation and Drainage (ICID)	http://www.unesco.org
International Fertilizer Association	http://www.fertilizer.org
International HCH & Pesticides Association (IHPA)	http://www.ihpa.info/
International Water Management Institute (IWMI)	http://www.cgiar.org/iwmi
International Water Resources Association (IWRA)	http://www.iwra.siu.edu/
International River Network (IRN)	http://www.irn.org
Wetland International	http://www.ramsar.org
Water World	http://www.waterworld.com
World Water	http://www.waterworld.org
World Water Council	http://www.waterworldcouncil.org
World Water Forum	http://www.waterworldforum.org

RELATED ORGANIZATIONS OF THE UNITED NATIONS FAMILY

Organization	Web site
Food and Agriculture Organization (FAO)	http://www.fao.org
United Nations Development Programme (UNDP)	http://www.undp.org
United Nations Educational, Scientific and Cultural Organization (UNESCO)	http://www.unesco.org
United Nations Environment Programme (UNEP)	http://www.unep.org
World Meteorological Organization (WMO)	http://www.wmo.ch

RELATED NATIONAL ORGANIZATION

Organization	Web site
Asosiasi Produsen Pupuk Indonesia.	http://www.appi.or.id/
Badan Meteorologi Klimatologi dan Geofisika.	http://www.bmkg.go.id/
Badan Perencanaan Pembangunan Daerah dan Statistik Provinsi Kepulauan Bangka Belitung.	http://www.bappeda.babelprov.go.id/
Badan Pusat Statistik.	http://www.bps.go.id/
Badan Pusat Statistik Provinsi Kepulauan Bangka Belitung.	http://www.babel.bps.go.id/
Bank Padi Indonesia.	http://www.knowledgebank.irri.or.id/
Dinas Pekerjaan Umum Provinsi Kepulauan Bangka Belitung.	http://www.pu.babelprov.go.id/
Indonesian Center for Rice Research (ICRR).	http://www.bppadi.litbang.go.id/
Kepustakaan, Kementerian Pertanian Republik Indonesia.	http://www.pustaka-deptan.go.id/
Pemerintah Kota Pangkalpinang.	http://www.pangkalpinangkota.go.id/
Pemerintah Provinsi Kepulauan Bangka Belitung.	http://www.babelprov.go.id/
Penelitian dan Pengembangan, Kementerian Pertanian Republik Indonesia.	http://www.babel.litbang.deptan.go.id/
Profil Wilayah Indonesia.	http://www.wilayahindonesia.com/

SOME OTHER USEFUL SITES

Organization	Web site
Association of Climate Change Officers (ACCO).	http://www.accoonline.org/
Australia Surface Water Data.	http://www.wrc.wa.gov.au/
Country Profile.	http://www.indexmundi/
Dictionary and Thesaurus Merriam-Webster.	http://www.merriam-webster.com/
Encyclopedia.	http://www.wikipedia.org/
Environmental Information Center.	http://www.eicinformation.org/
Environmental Protection Agency (EPA)	http://www.epa.org/
European Commision Environment.	http://www.ec.europa.eu/
Food and Fertilizer Technology Center (FFTC).	http://www.agnet.org/
Natural Resources Conservation Service, Formerly SCS (USDA).	http://www.ncg.nrcs.usda.gov
United States Geologycal Survey (USGS).	http://www.usgs.gov
Satelite Imagery.	http://www.earth.google.com/

Only major sites have been included here. The address of an organization's site may also change with time.

Appendix 2

WATER REQUIREMENT

Irrigation Water Requirement

Type of Use	Water Requirement (Ha)		Water Requirement	
	Lt/sec	Area (Ha)	Lt/year	m^3/year
Agriculture				
Baturusa Region	1.2	9,700.00	362,050,560,000.00	362,050,560.00
Cerucuk Region	1.2	1,266.00	47,253,196,800.00	47,253,196.80
Amount		**10,966.00**	**409,303,756,800.00**	**409,303,756.80**
Public Plantation				
Baturusa Region	0.8	25,157.99	78,251,412,096.00	78,251,412.09
Cerucuk Region	0.8	1,267.70	3,943,054,080.00	3,943,054.08
Amount		**26,425.69**	**82,194,466,176.00**	**82,194,466.17**
Large Plantation				
Baturusa Region	0.8	256,238.63	797,004,634,752.00	797,004,634.75
Cerucuk Region	0.8	164,464.10	511,549,136,640.00	511,549,136.64
Amount		**420,702.73**	**1,308,553,771,392.00**	**1,308,553,771.39**

Type of Use	Water Requirement (per Head)		Water Requirement	
	Lt/sec	No. of Livestock	Lt/year	m^3/year
Animal Husbandry				
Baturusa Region	200	23,776.00	1,735,648,000.00	1,735,648.00
Cerucuk Region	200	5,368.00	391,864,000.00	391,864.00
Amount		**29,144.00**	**2,127,512,000.00**	**2,127,512.00**
Total				
Baturusa Region				**1,239,042,254.85**
Cerucuk Region				**563,137,251.52**

Source : Departement of Public Work, Directorate General of Water Resources, Regional of Sumatera VIII, 2007.

Non Irrigation Water Requirement

Water Requirement (m3/year)	River Zone	
	Baturusa	**Cerucuk**
Public services	12,725,249.04	3,464,040.38
Commercial	9,089,463.60	2,474,314.56
Industry	12,725,249.04	3,454,040.38
Shrinkage	5,453,678.16	1,484,588.74
Flushing	1,870,820.34	2,735,155.46
Maintenance flow	9,354,101.68	13,675,777.30
Total	**39,993,639.84**	**10,886,984.06**

Water Balance

	Amount of Water (m3/year)	
	Baturusa	**Cerucuk**
Total Water Availability	3,107,386,842.43	3,897,004,364.95
Water Requirement		
Total Irrigation	1,239,042,254.85	563,137,251.52
Total Non Irrigation	39,993,639.84	10,886,984.06
	1,870,820.34	2,735,155.46
	9,354,101.68	13,675,777.30
Total Water Requirement	1,290,260,816.71	590,435,168.34
Total Water Balance	**1,817,126,05.72**	**3,306,569,196.61**

Source : Departement of Public Work, Directorate General of Water Resources, Regional of Sumatera VIII, 2007.

Detail of Non Irrigation Water Requirement

No.		Regencies/City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
I	**Bangka**													
	a.	**Discharge**	**30,399.62**	**25,502,17**	**16,842.39**	**75,637.29**	**31,751.03**	**51,836.43**	**26,146.84**	**3,767.19**	**928.28**	**272.45**	**25,541.60**	**43,227.79**
	1.	Domestic	344.10	344.10	344.10	344.10	344.10	344.10	344.10	344.10	344.10	344.10	344.10	344.10
	2.	Public Service	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44
	3.	Industry	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44	120.44
	4.	Commercial	86.03	86.03	86.03	86.03	86.03	86.03	86.03	86.03	86.03	86.03	86.03	86.03
	5.	Shrinkage	51.62	51.62	51.62	51.62	51.62	51.62	51.62	51.62	51.62	51.62	51.62	51.62
	6.	Flushing	613.99	510.04	336.85	1,512.75	635.02	1,036.73	522.94	75.34	18.57	5.45	510.83	864.56
	7.	Maintenance Flow	3,069.96	2,550.22	1,684.24	7,563.73	6,475.40	5,183.64	2,614.68	376.72	92.83	27.25	2,554.16	4,322.78
	b.	**Total Water Requirement**	**4,406.59**	**3,782.89**	**2,743.72**	**9,799.11**	**4,532.75**	**6,943.00**	**3,860.25**	**1,174.69**	**834.02**	**755.33**	**3,787.62**	**5,909.97**
II	**Western Bangka**													
	a.	**Discharge**	**15,608.31**	**13,401.60**	**8,563.01**	**38,876.93**	**16,142.87**	**26,643.49**	**13,293.59**	**1,915.31**	**477.13**	**138.52**	**13,128.17**	**21,977.89**
	1.	Domestic	202.20	202.20	202.20	202.20	202.20	202.20	202.20	202.20	202.20	202.20	202.20	202.20
	2.	Public Service	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77
	3.	Industry	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77	70.77
	4.	Commercial	50.55	50.55	50.55	50.55	50.55	50.55	50.55	50.55	50.55	50.55	50.55	50.55
	5.	Shrinkage	30.33	30.33	30.33	30.33	30.33	30.33	30.33	30.33	30.33	30.33	30.33	30.33
	6.	Flushing	312.17	268.03	171.26	777.54	322.86	532.87	265.87	38.31	9.54	2.77	262.56	439.56
	7.	Maintenance Flow	1,560.83	1,340.16	856.30	3,887.69	1,614.29	2,664.35	1,329.36	191.53	47.71	13.85	1,312.82	2,497.79
	b.	**Total Water Requirement**	**2,297.62**	**2,032.81**	**1,452.18**	**5,089.85**	**2,361.73**	**3,621.84**	**2,019.85**	**654.46**	**481.88**	**441.24**	**2,000.0**	**3,064.97**

No.		Regencies/District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
III	**Central Bangka**													
	a.	**Discharge**	**-19,819.89**	**17,017.74**	**10,873.56**	**49.367.05**	**20,498.68**	**33,832.67**	**16,880.58**	**2,432.12**	**605.87**	**185.90**	**16.670.53**	**27,908.17**
	1.	Domestic	193.75	193.75	193.75	193.75	193.75	193.75	193.75	193.75	193.75	193.75	193.75	193.75
	2.	Public Service	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81
	3.	Industry	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81	67.81
	4.	Commercial	48.44	48.44	48.44	48.44	48.44	48.44	48.44	48.44	48.44	48.44	48.44	48.44
	5.	Shrinkage	29.06	29.06	29.06	29.06	29.06	29.06	29.06	29.06	29.06	29.06	29.06	29.06
	6.	Flushing	396.40	340.35	217.47	987.34	409.97	676.65	337.61	48.64	12.12	3.52	333.41	558.16
	7.	Maintenance Flow	1,981.99	1,701.77	1.087.36	4,936.71	2,049.87	3,383.27	1,688.06	243.21	60.59	17.59	1,667.05	2,790.82
	b.	**Total Water Requirement**	**2,785.26**	**2,449.00**	**1,711.70**	**6.330.92**	**2,866.72**	**4,466.80**	**2,432.55**	**698.73**	**479.58**	**427.98**	**2,407.34**	**3,755.85**
IV	**Southern Bangka**													
	a.	**Discharge**	**23,328.13**	**20,029.99**	**12,798.25**	**58,105.32**	**24,127.08**	**39,521.24**	**19,838.55**	**2,865.62**	**713.11**	**207.03**	**19,621.32**	**32,818.08**
	1.	Domestic	210.43	210.43	210.43	210.43	210.43	210.43	210.43	210.43	210.43	210.43	210.43	210.43
	2.	Public Service	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65
	3.	Industry	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65	73.65
	4.	Commercial	52.61	52.61	52.61	52.61	52.61	52.61	52.61	52.61	52.61	52.61	52.61	52.61
	5.	Shrinkage	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56	31.56
	6.	Flushing	466.56	400.60	255.97	1,162.11	482.54	796.43	397.37	57.25	14.26	4.04	392.43	656.96
	7.	Maintenance Flow	2,332.81	2,003.00	1,279.83	5,810.53	2,412.71	3,982.13	1,986.86	286.26	71.31	20.70	1,932.13	3,284.81
	b.	**Total Water Requirement**	**3,241.28**	**2,845.50**	**1,977.69**	**7,414.54**	**3,337.15**	**5,220.45**	**2,826.13**	**795.42**	**527.48**	**466.75**	**2,796.46**	**4,383.67**

No.		Regencies/City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
V	**Pangkalpinang City**													
	a.	**Discharge**	**10,315.35**	**7,999.83**	**5,659.19**	**24,864.59**	**10,668.63**	**17,040.35**	**7,785.57**	**1,265.84**	**305.16**	**91.55**	**7,396.37**	**14,524.93**
	1.	Domestic	202.41	202.41	202.41	202.41	202.41	202.41	202.41	202.41	202.41	202.41	202.41	202.41
	2.	Public Service	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84
	3.	Industry	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84	70.84
	4.	Commercial	50.60	50.60	50.60	50.60	50.60	50.60	50.60	50.60	50.60	50.60	50.60	50.60
	5.	Shrinkage	30.36	30.36	30.36	30.36	30.36	30.36	30.36	30.36	30.36	30.36	30.36	30.36
	6.	Flushing	206.31	160.00	113.18	497.29	213.37	340.81	175.71	25.32	6.10	1.83	167.93	290.50
	7.	Maintenance Flow	1,031.53	799.98	565.92	2,486.45	1,066.86	1,704.04	878.56	126.58	30.52	9.15	739.64	1,452.49
	b.	**Total Water Requirement**	1.664.90	**1,385.04**	**1,104.16**	**3.408.80**	**1,705.30**	**2.469.90**	**1,479.33**	**576.96**	**461.68**	**436.05**	**1,432.63**	**2,168.05**
VI	**Belitung**													
	a.	**Discharge**	**70,840.01**	**7,791.72**	**71,167.93**	**94,676.23**	**89,167.05**	**54,689.03**	**23,500.61**	**2,889.97**	**785.89**	**15,038.80**	**112,630.19**	**123,676.27**
	1.	Domestic	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00	192.00
	2.	Public Service	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20
	3.	Industry	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20	67.20
	4.	Commercial	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00
	5.	Shrinkage	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80	28.80
	6.	Flushing	1,416.80	155.83	1,426.36	1,893.52	1,783.34	1,087.78	470.01	57.80	17.92	300.77	2,252.60	2,473.53
	7.	Maintenance Flow	7,084.00	779.17	7,116.79	9,467.62	8,916.70	5,438.90	2,350.06	289.00	89.59	1,503.83	11,263.02	12,367.63
	b.	**Total Water Requirement**	**8.904.00**	**1,338.21**	**8,943.35**	**11,764.35**	**11,103.25**	**6,929.88**	**3,223.27**	**750.00**	**540.71**	**2,207.80**	**13,918.82**	**15,244.35**

No.		Regencies/District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
VII		Eastern Belitung												
	a.	**Discharge**	**97,353.96**	**10,708.00**	**97,804.61**	**130,111.57**	**122,540.42**	**74,745.71**	**21,296,40**	**3,971.63**	**1,231.21**	**20,666.82**	**154,785.33**	**169,965.73**
	1.	Domestic	121,84	121,84	121,84	121,84	121,84	121,84	121,84	121,84	121,84	121,84	121,84	121,84
	2.	Public Service	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64
	3.	Industry	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64	42.64
	4.	Commercial	30.46	30.46	30.46	30.46	30.46	30.46	30.46	30.46	30.46	30.46	30.46	30.46
	5.	Shrinkage	18.28	18.28	18.28	18.28	18.28	18.28	18.28	18.28	18.28	18.28	18.28	18.28
	6.	Flushing	1,947.08	214.16	1,956.09	2,602.23	2,450.81	1,494.91	645.93	79.43	24.62	413.34	3,095.71	3,399.31
	7.	Maintenance Flow	9,735.40	1,070.80	9,780.46	13,011.16	12,254.04	7,474.57	3,229.64	397,16	123,12	2,066.68	15,478.53	16,996.57
	b.	**Total Water Requirement**	**11,938.34**	**1,540.82**	**11,992,42**	**15,869.25**	**14,960.71**	**9,225.35**	**4,131.43**	**732.46**	**403.61**	**2,735.88**	**18,830.10**	**20,651.75**

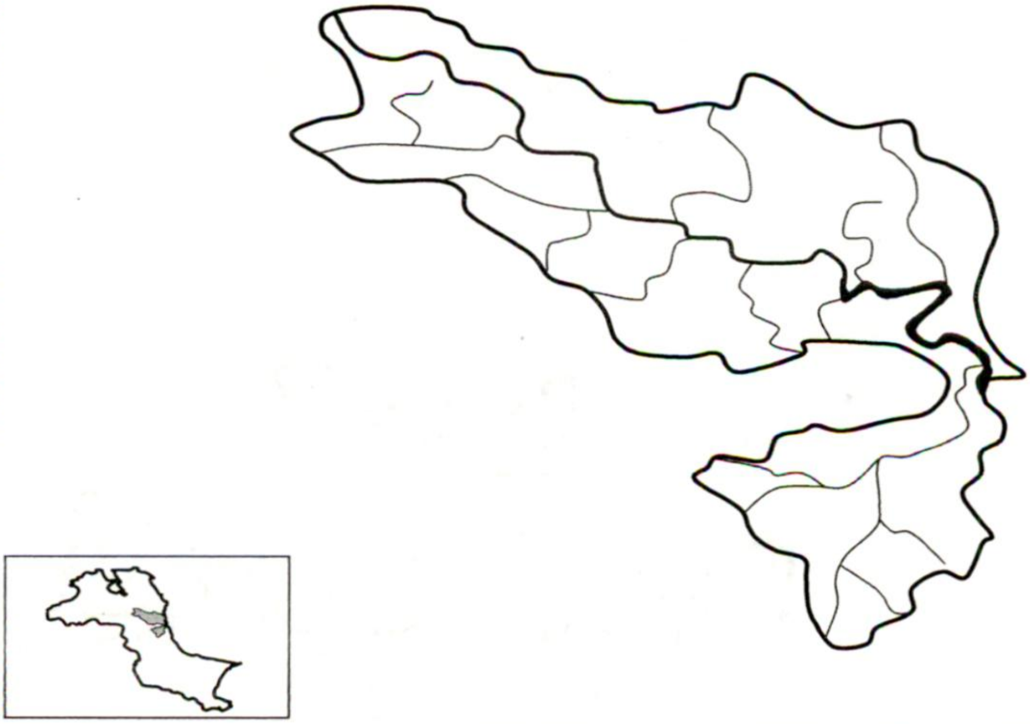
Source : Departement of Public Work, Directorate General of Water Resources, Regional of Sumatera VIII, 2007.

Appendix 3

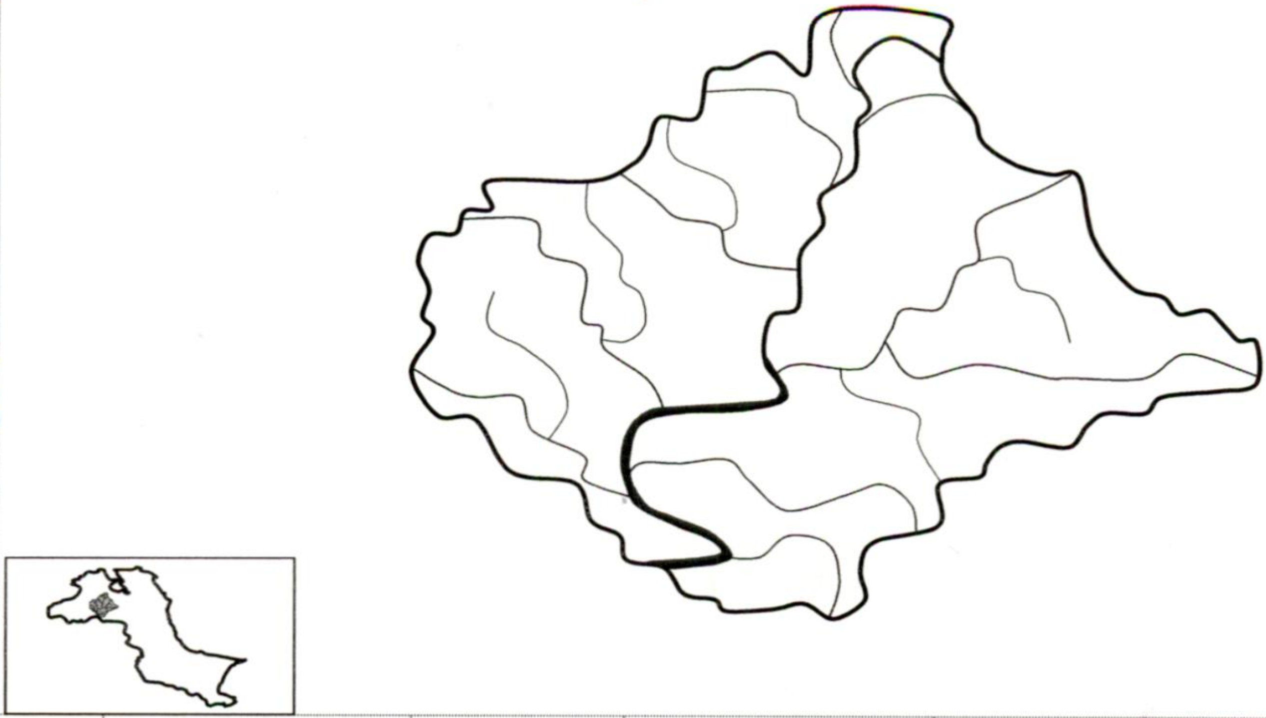
RIVER BASINS / CATCHMENT AREA

Baturusa River Region (Bangka Island)					
S.No.	**Name of River**	**Catchment Area**	**%**	**Discharge**	
		(sq. km)		**(m^3/year)**	**(Cumec)**
1.	Baturusa river	648,844	9,67	300,557,525.28	9,531
2.	Mecong river	624,127	9,30	289,108,116.25	9,168
3.	Kurau river	570,321	8,50	264,184,100.30	8,377
4.	Jeruk river	535,324	7,98	247,972,789.55	7,863
5.	Selan river	527,550	7,86	244,371,717.18	7,749
6.	Bangka Kota river	521,934	7,78	241,770,273.60	7,666
7.	Kepoh river	454,804	6,78	210,674,314.21	6,680
8.	Menduk river	387,284	5,77	179,397,699.02	5,689
9.	Layang river	359,584	5,36	166,566,504.69	5,282
10.	Kampak river	357,642	5,33	165,666,931.43	5,253
11.	Balar river	348,492	5,19	161,428,468.32	5,119
12.	Nyireh river	299,243	4,46	138,615,345.97	4,395
13.	Semubur river	282,220	4,21	130,729,951.71	4,415
14.	Ulim river	255,945	3,82	118,558,845.90	3,759
15.	Antan river	194,722	2,90	90,499,127.12	2,860
16.	Gusung river	191,381	2,85	88,651,509.06	2,811
17.	Nibung river	148,814	2,22	68,933,622.82	2,186
Total		**6,708.231**	**100,00**	**3,107,386,842.43**	**98,535**

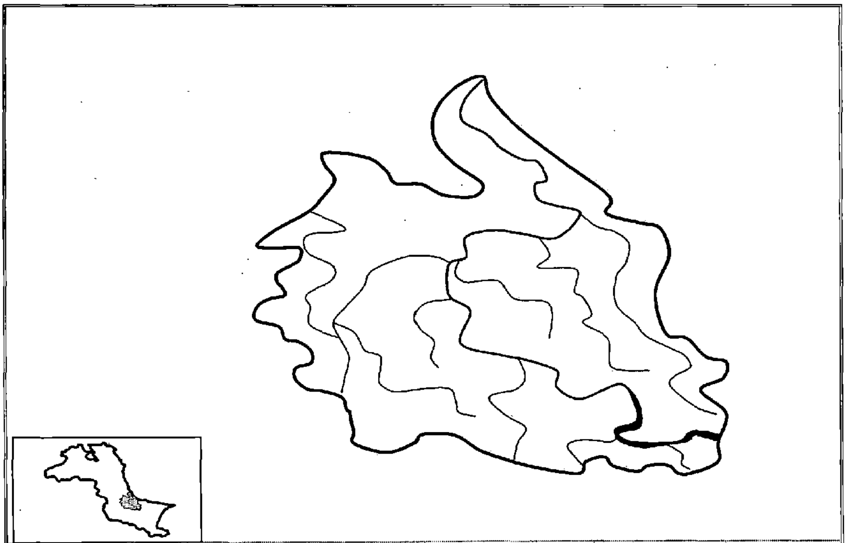
Source : Departement of Public Work, Directorate General of Water Resources, Regional of Sumatera VIII, 2007.



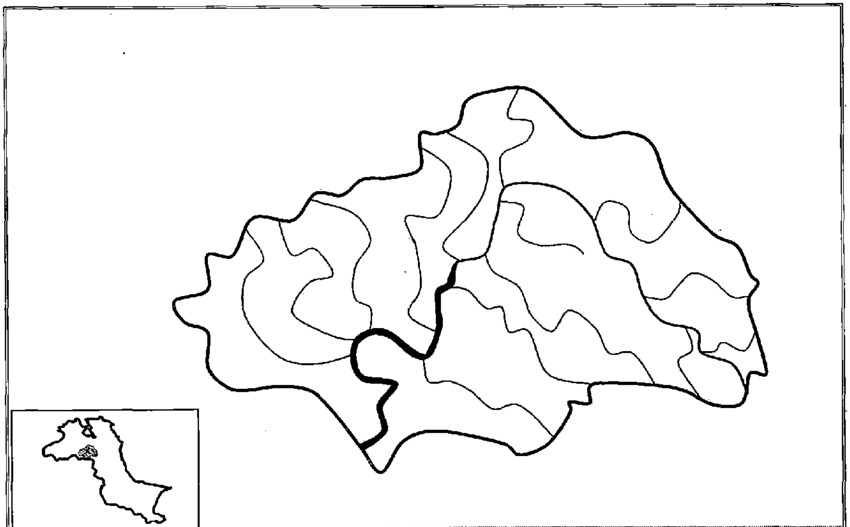
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
1/17	Baturusa river	648,844	300,557,525.28	9,531



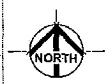
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
2/17	Mecong river	624,127	289,108,116.25	9,168

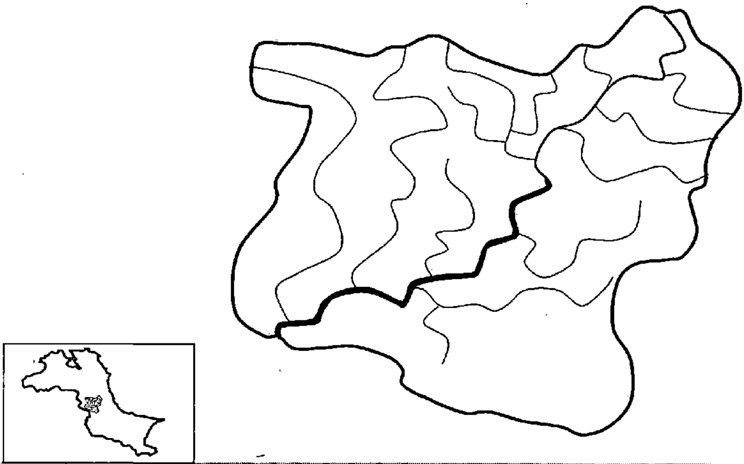


No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
3/17	Kurau river	570,321	264,184,100.30	8,377

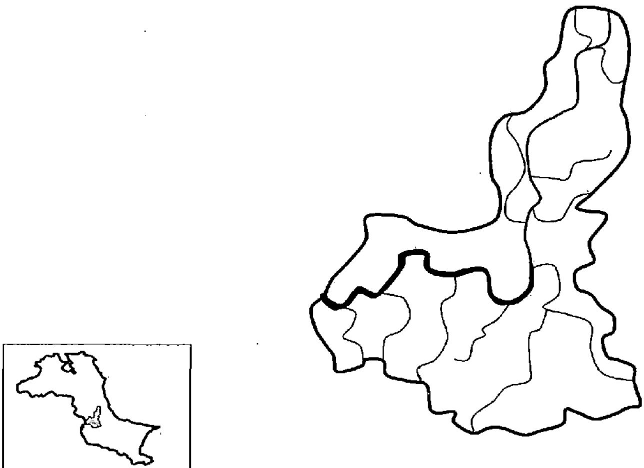


No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
4/17	Jeruk river	535,324	247,972,789.55	7,863

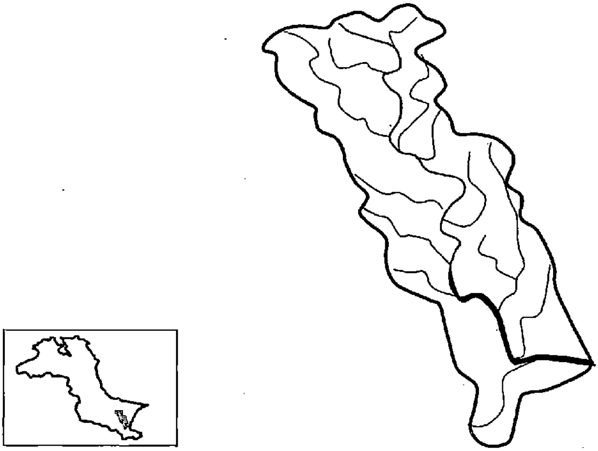




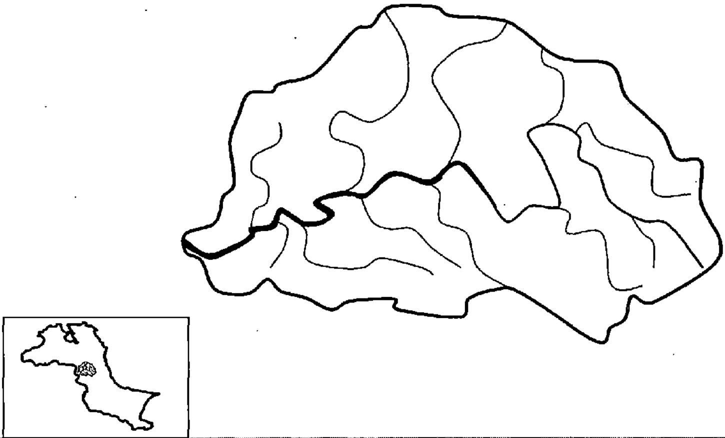
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
5/17	Selan river	527,550	244,371,717.18	7,749



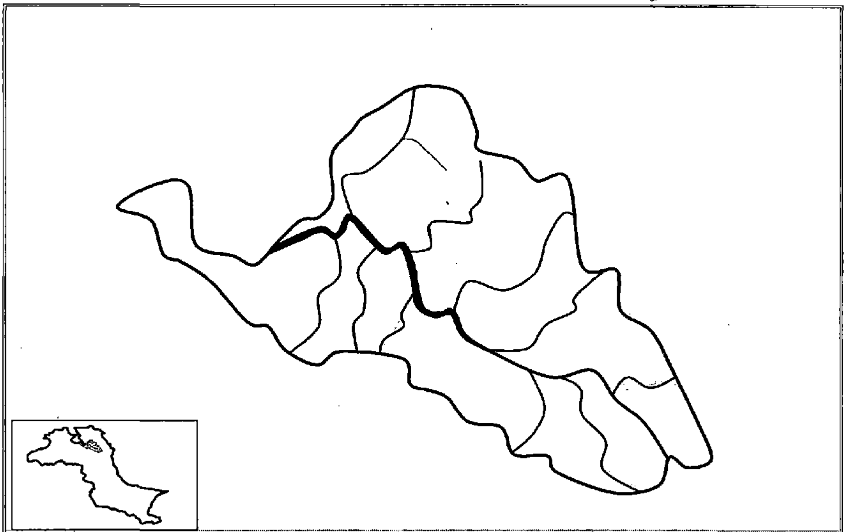
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
6/17	Bangka Kota river	521,934	241,770,273.60	7,666



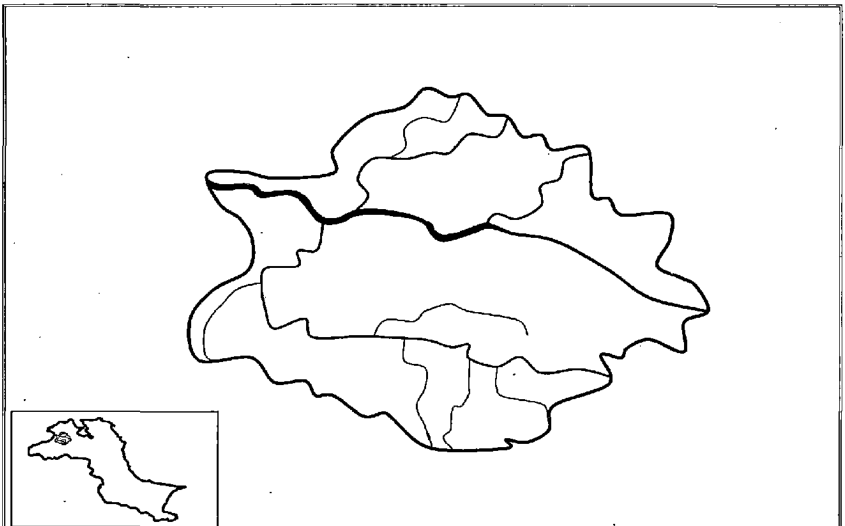
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
7/17	Kepoh river	454,804	210,674,314.21	6,680



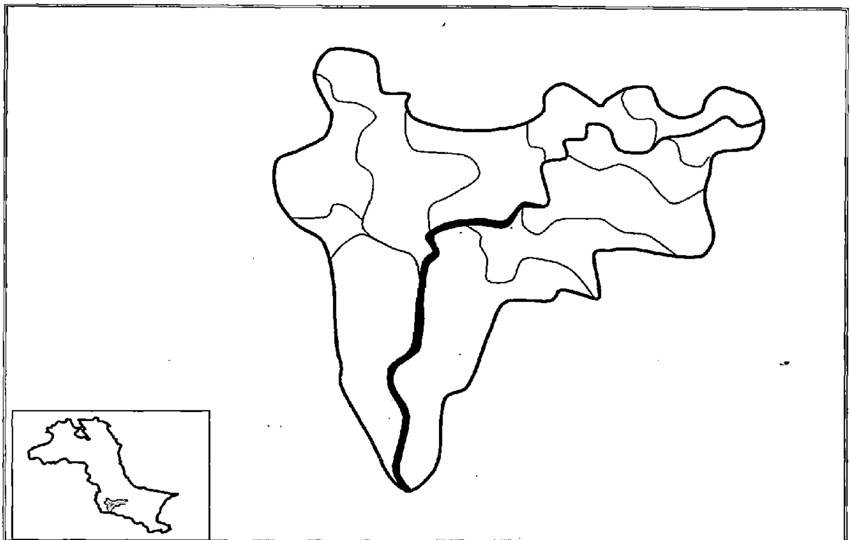
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
8/17	Menduk river	387,284	179,397,699.02	5,689



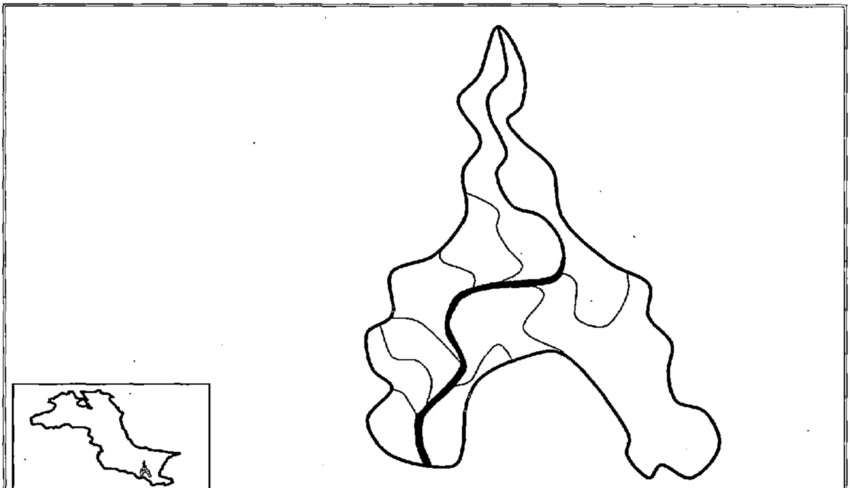
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
9/17	Layang river	359,584	166,566,504.69	5,282



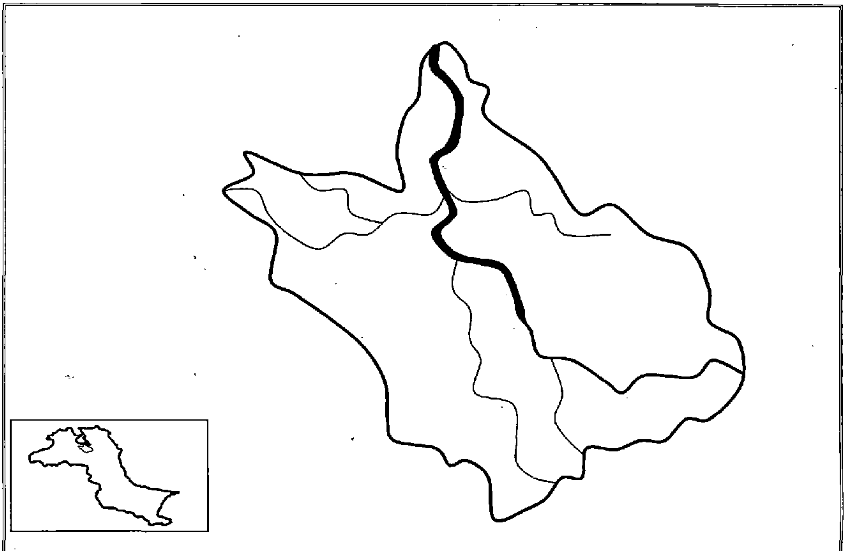
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
10/17	Kampak river	357,642	165,666,931.43	5,253



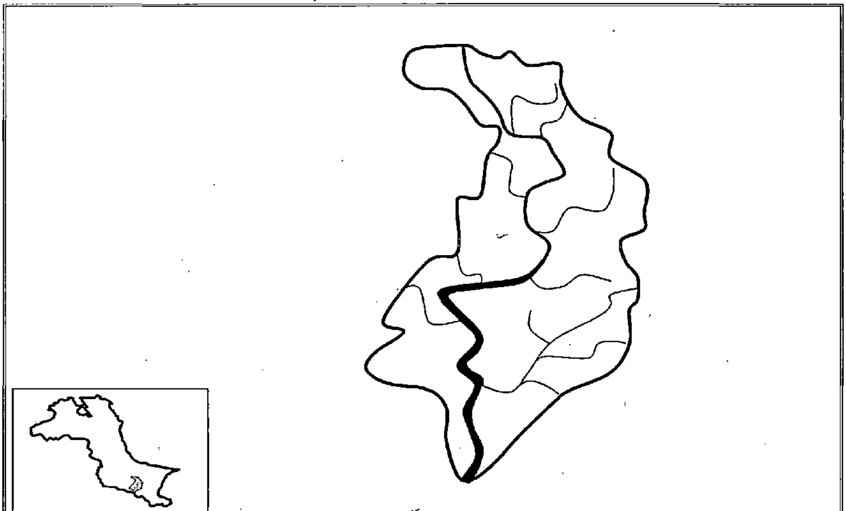
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)	NORTH
11/17	Balar river	348,492	161,428,468.32	5,119	



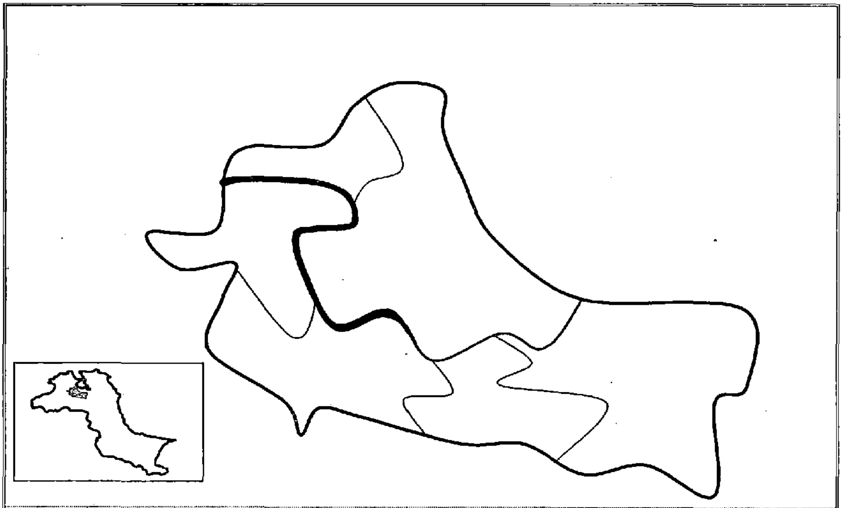
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)	NORTH
12/17	Nyireh river	299,243	138,615,345.97	4,395	



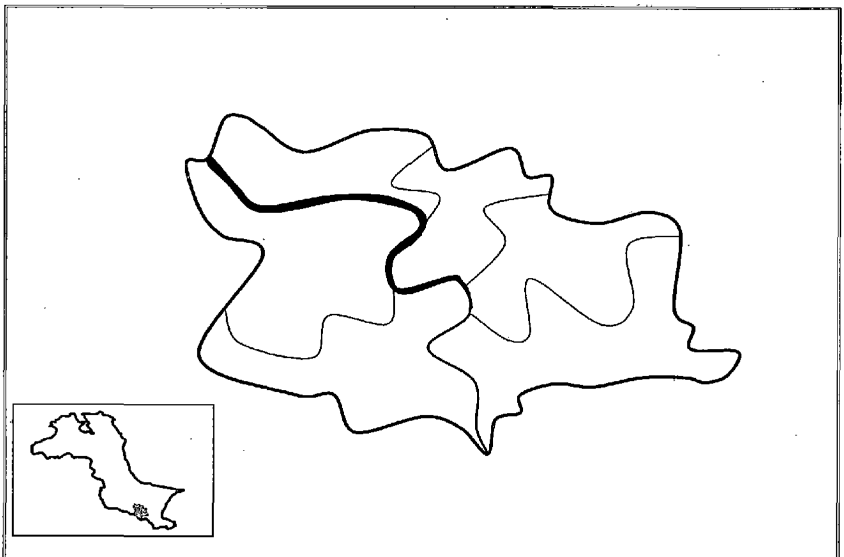
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
13/17	Semubur river	282,220	130,729,951.71	4,415



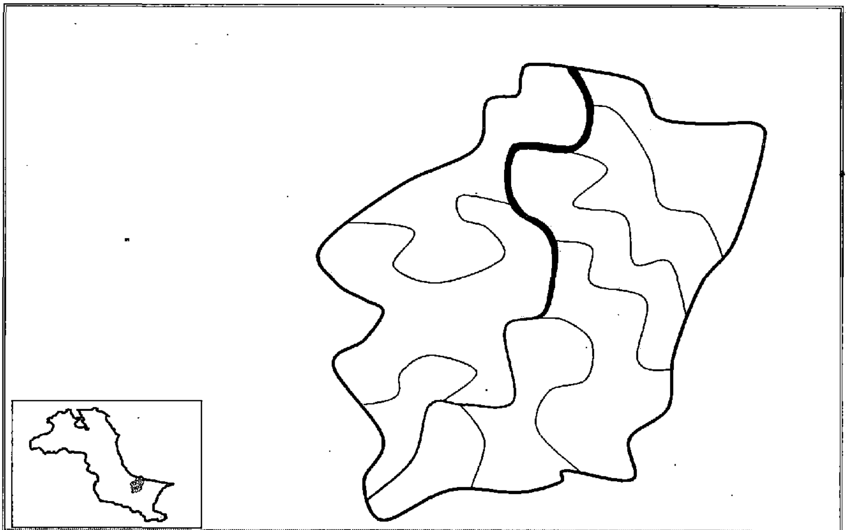
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
14/17	Ulim river	255,945	118,558,845.90	3,759



No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
15/17	Antan river	194,722	90,499,127.12	2,860



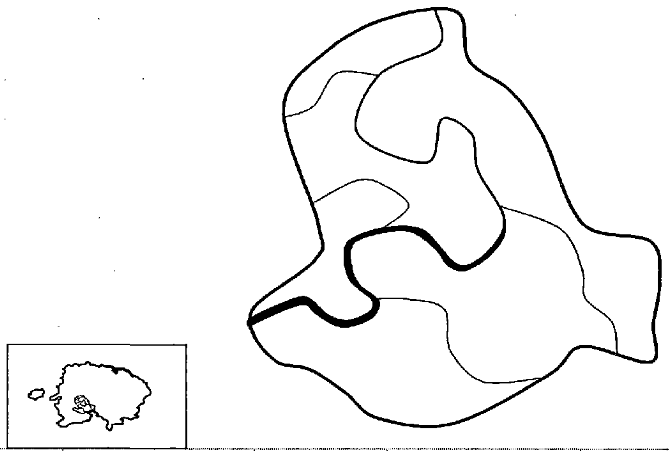
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
16/17	Gusung river	191,381	88,651,509.06	2,811



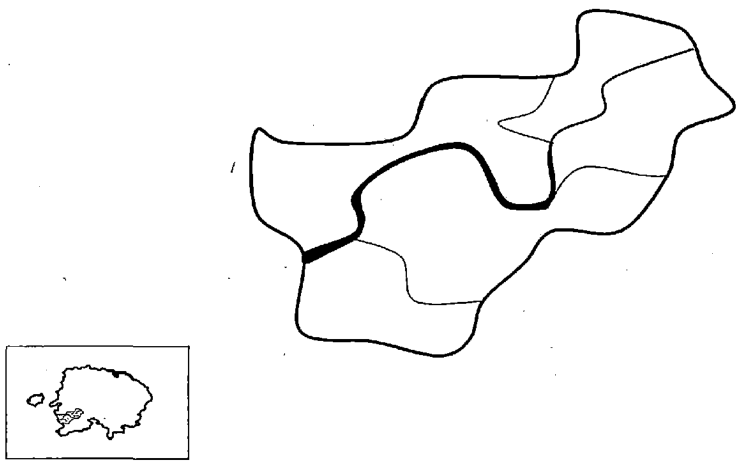
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)	
17/17	Nibung river	148,814	Nibung river	148,814	

Cerucuk River Region (Belitung Island)					
S.No.	Name of River	Catchment Area	%	Discharge	
		(sq. km)		(m³/year)	(Cumec)
1.	Membalong river	102,966	3,57	139,293,522.98	4,417
2.	Dudat river	76,687	2,66	103,743,006.40	3,290
3.	Tebel river	38,691	1,34	52,341,604.97	1,660
4.	Brang river	183,289	6,36	247,955,349.67	7,863
5.	Cerucuk river	551,388	19,14	745,923,674.33	23,653
6.	Kubu river	42,881	1,49	58,009,882.48	1,839
7.	Padang river	72,152	2,50	97,608,009.15	3,095
8.	Buding river	482,615	16,75	652,883,813.07	20,703
9.	Manggar river	282,624	9,81	382,336,816.42	12,124
10.	Semulu river	188,273	6,54	254,697,759.00	8,076
11.	Senusur river	40,279	1,40	54,489,868.62	1,728
12.	Linggang river	697,275	24,21	943,281,192.23	29,911
13.	Balok river	121,552	4,22	164,436,865.62	5,214
Total		**2,880.672**	**100,00**	**3,897,004,364.95**	**123,573**

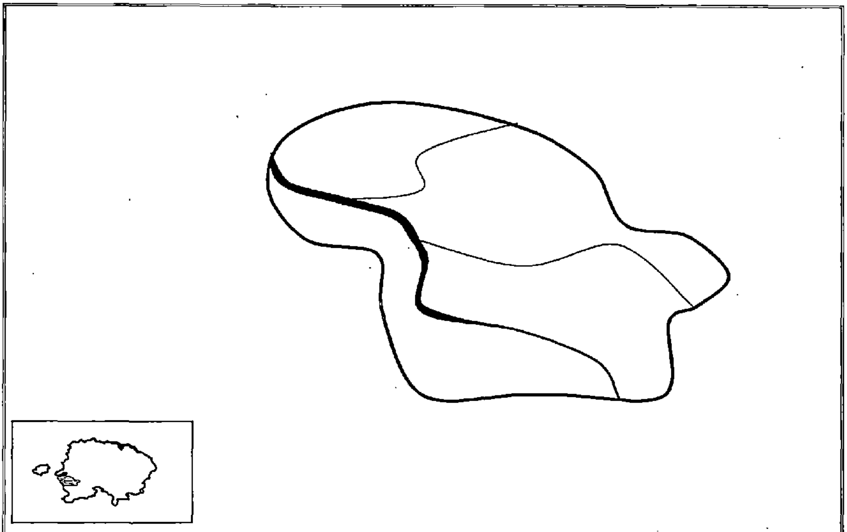
Source : Departement of Public Work, Directorate General of Water Resources, Regional of Sumatera VIII, 2007.



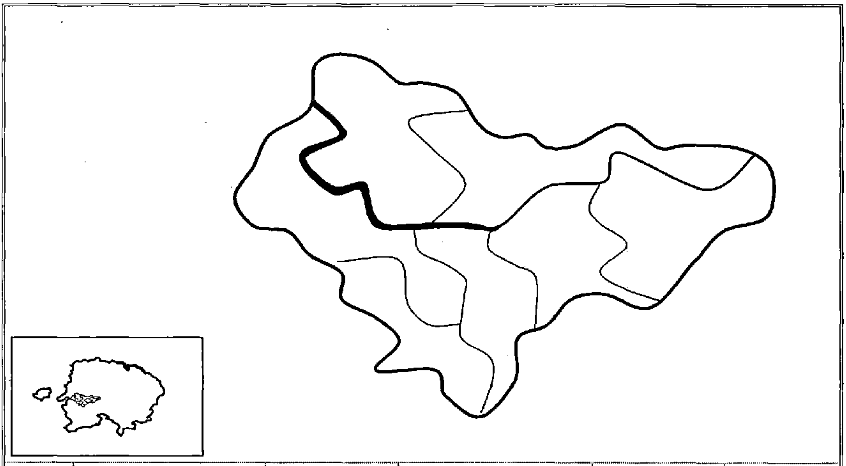
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
1/13	Membalong river	102,966	139,293,522.98	4,417



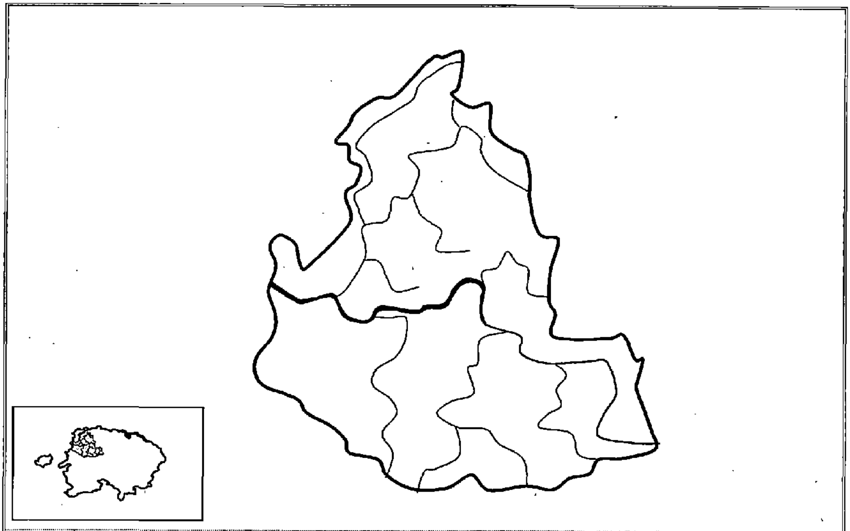
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
2/13	Dudat river	76,687	103,743,006.40	3,290



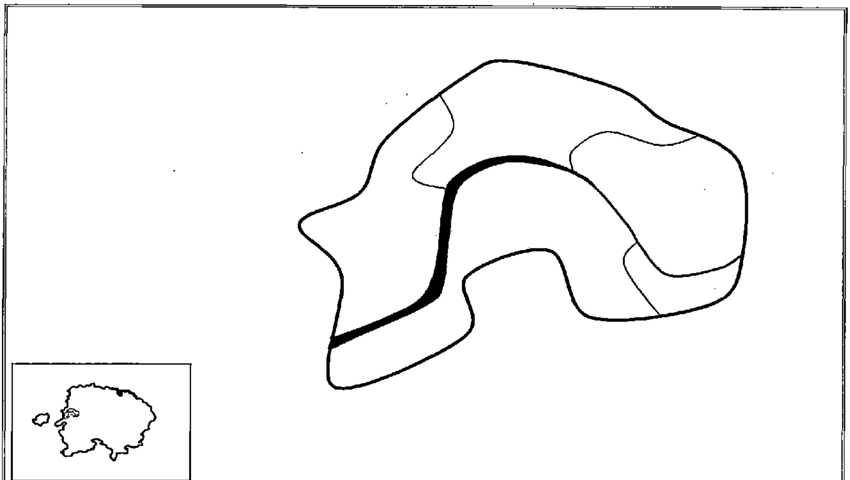
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
3/13	Tebel river	38,691	52,341,604.97	1,660



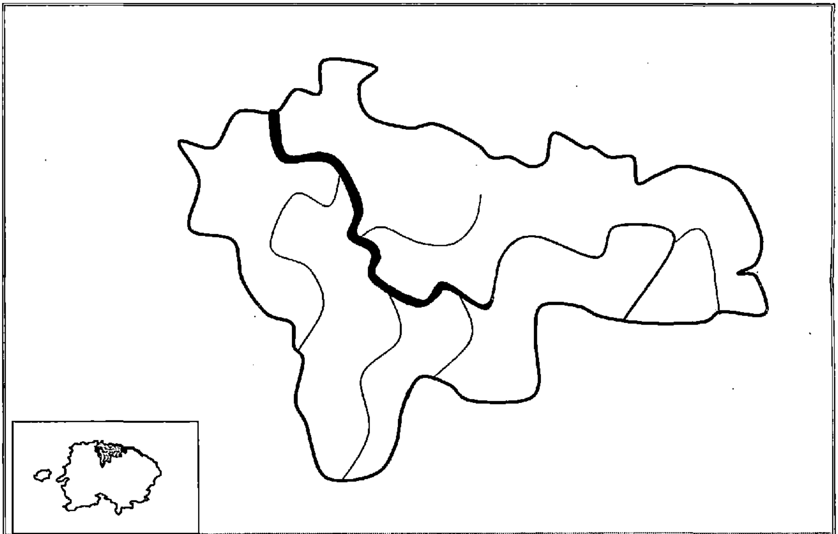
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
4/13	Brang river	183,289	247,955,349.67	7,863



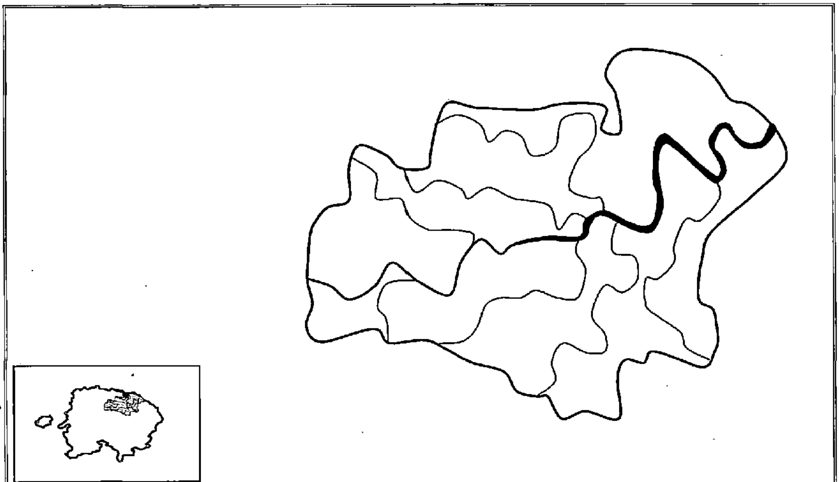
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
5/13	Cerucuk river	551,388	745,923,674.33	23,653



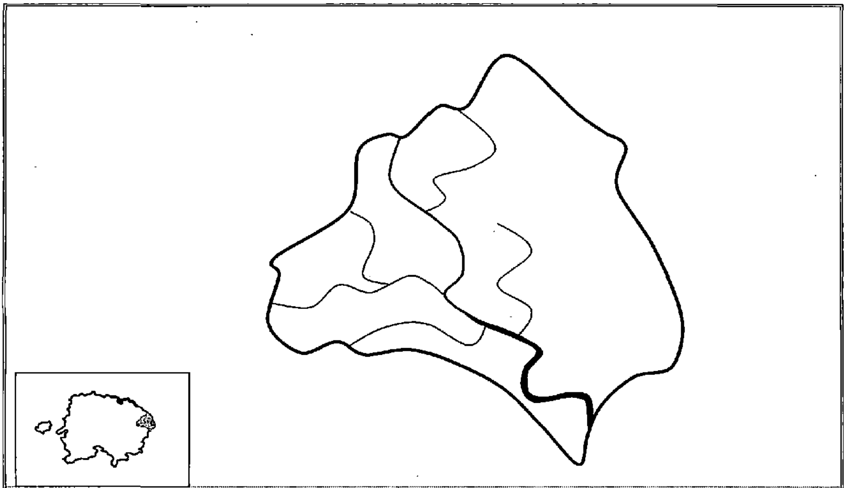
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
6/13	Kubu river	42,881	58,009,882.48	1,839



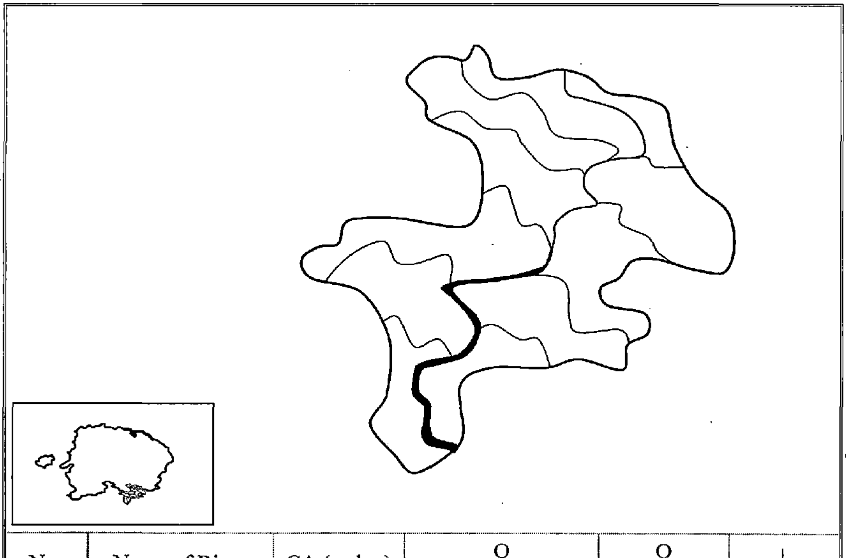
No.	Name of River	CA (sq.km)	Q (m³/yr)	Q (cumec)	NORTH
7/13	Padang river	72,152	97,608,009.15	3,095	



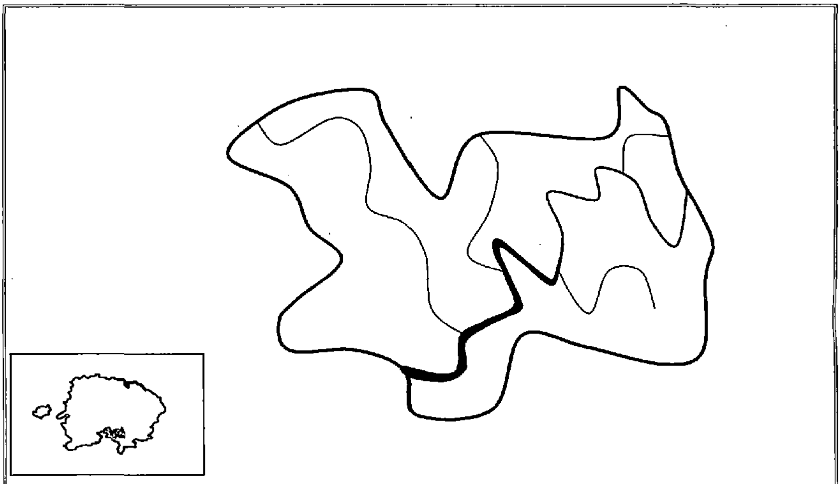
No.	Name of River	CA (sq.km)	Q (m³/yr)	Q (cumec)	NORTH
8/13	Buding river	482,615	652,883,813.07	20,703	



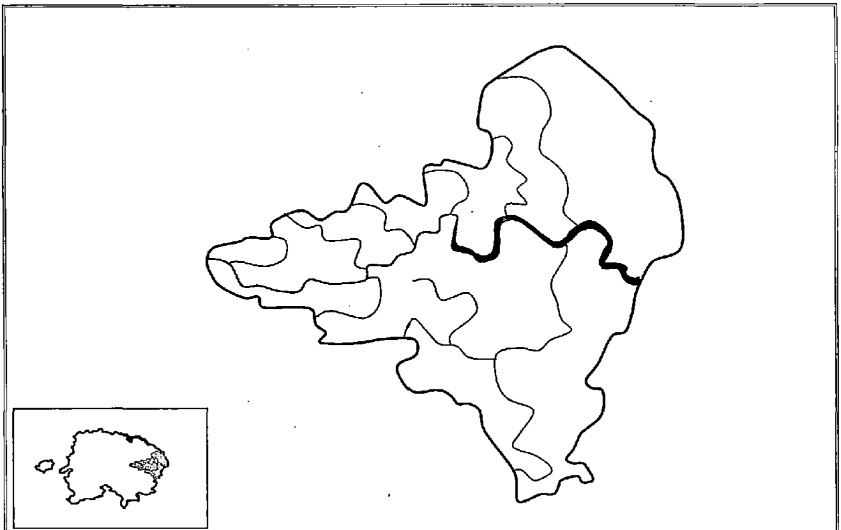
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
9/13	Manggar river	282,624	382,336,816.42	12,124



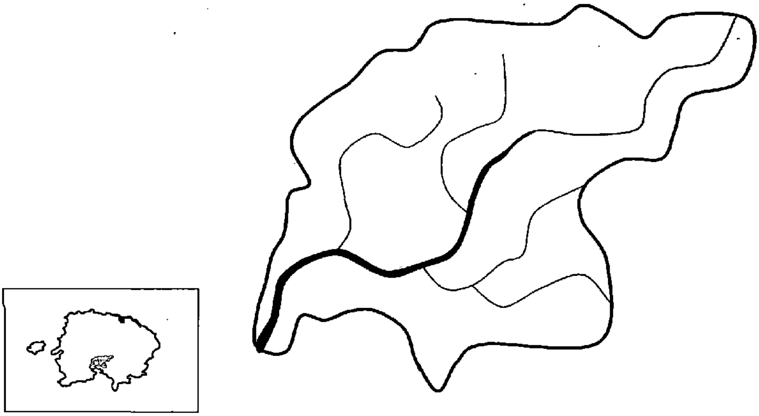
No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
10/13	Semulu river	188,273	254,697,759.00	8,076



No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
11/13	Senusur river	40,279	54,489,868.62	1,728



No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)
12/13	Linggang river	697,275	943,281,192.23	29,911



No.	Name of River	CA (sq.km)	Q (m^3/yr)	Q (cumec)	NORTH
13/13	Balok river	121,552	164,436,865.62	5,214	

Appendix 4

REFERENCE DAILY INTAKE (RDI)

Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals, Macronutrients
Food and Nutrition Board, Institute of Medicine, National Academies

Life Stage Group	Total Water*a* (L/d)	Carbohydrate (g/d)	Total Fiber (g/d)	Fat (g/d)	Linoleic Acid (g/d)	α-Linolenic Acid (g/d)	Protein*b* (g/d)
Infants							
0–6 mo	0.7*	60*	ND	31*	4.4*	0.5*	9.1*
7–12 mo	0.8*	95*	ND	30*	4.6*	0.5*	**11.0***c*
Children							
1–3 y	1.3*	**130**	19*	ND	7*	0.7*	**13**
4–8 y	1.7*	**130**	25*	ND	10*	0.9*	**19**
Males							
9–13 y	2.4*	**130**	31*	ND	12*	1.2*	**34**
14–18 y	3.3*	**130**	38*	ND	16*	1.6*	**52**
19–30 y	3.7*	**130**	38*	ND	17*	1.6*	**56**
31–50 y	3.7*	**130**	38*	ND	17*	1.6*	**56**
51–70 y	3.7*	**130**	30*	ND	14*	1.6*	**56**
> 70 y	3.7*	**130**	30*	ND	14*	1.6*	**56**
9–13 y	2.1*	**130**	26*	ND	10*	1.0*	**34**
Females							
14–18 y	2.3*	**130**	26*	ND	11*	1.1*	**46**
19–30 y	2.7*	**130**	25*	ND	12*	1.1*	**46**
31–50 y	2.7*	**130**	25*	ND	12*	1.1*	**46**
51–70 y	2.7*	**130**	21*	ND	11*	1.1*	**46**
> 70 y	2.7*	**130**	21*	ND	11*	1.1*	**46**
Pregnancy							
14–18 y	3.0*	**175**	28*	ND	13*	1.4*	**71**
19–30 y	3.0*	**175**	28*	ND	13*	1.4*	**71**
31–50 y	3.0*	**175**	28*	ND	13*	1.4*	**71**
Lactation							
14–18 y	3.8*	**210**	29*	ND	13*	1.3*	**71**
19–30 y	3.8*	**210**	29*	ND	13*	1.3*	**71**
31–50 y	3.8*	**210**	29*	ND	13*	1.3*	**71**

NOTE: This table presents Recommended Dietary Allowances (RDAs) in **bold** type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy infants fed human milk, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover the needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

a Total water includes all water contained in food, beverages, and drinking water.

b Based on 0.8 g/kg body weight for the reference body weight.

c Change from 13.5 in prepublication copy due to calculation error.

Dietary Reference Intakes (DRIs): Estimated Energy Requirements (EER) for Men and Women 30 Years of Age*a*

Food and Nutrition Board, Institute of Medicine, National Academies

Height (m [in])	PAL*b*	Weight for BMI*c* of 18.5 kg/m2 (kg [lb])	Weight for BMI of 24.99 kg/m2 (kg [lb]) BMI of	EER, Men*d* (kcal/day)		EER, Women*d* (kcal/day)	
				BMI of 18.5 kg/m2	BMI of 24.99 kg/m2	BMI of 18.5 kg/m2	BMI of 24.99 kg/m2
1.50 (59)	Sedentary	41.6 (92)	56.2 (124)	1,848	2,080	1,625	1,762
	Low active			2,009	2,267	1,803	1,956
	Active			2,215	2,506	2,025	2,198
	Very active			2,554	2,898	2,291	2,489
1.65 (65)	Sedentary	50.4 (111)	68.0 (150)	2,068	2,349	1,816	1,982
	Low active			2,254	2,566	2,016	2,202
	Active			2,490	2,842	2,267	2,477
	Very active			2,880	3,296	2,567	2,807
1.80 (71)	Sedentary	59.9 (132)	81.0 (178)	2,301	2,635	2,015	2,211
	Low active			2,513	2,884	2,239	2,459
	Active			2,782	3,200	2,519	2,769
	Very active			3,225	3,720	2,855	3,141

a For each year below 30, add 7 kcal/day for women and 10 kcal /day for men. For each year above 30, subtract 7 kcal/day for women and 10 kcal/day for men.
b PAL = physical activity level.
c BMI = body mass index.
d Derived from the following regression equations based on doubly labeled water data:
Adult man: EER = 662 – 9.53 × age (y) + PA × (15.91 × wt [kg] + 539.6 × ht [m])
Adult woman: EER = 354 – 6.91 × age (y) + PA × (9.36 × wt [kg] + 726 × ht [m])
Where PA refers to coefficient for PAL

PAL = total energy expenditure ÷ basal energy expenditure
PA = 1.0 if PAL ≥ 1.0 < 1.4 (sedentary)
PA = 1.12 if PAL ≥ 1.4 < 1.6 (low active)
PA = 1.27 if PAL ≥ 1.6 < 1.9 (active)
PA = 1.45 if PAL ≥ 1.9 < 2.5 (very active)

Dietary Reference Intakes (DRIs): Acceptable Macronutrient Distribution Ranges

Food and Nutrition Board, Institute of Medicine, National Academies

Macronutrient	Range (percent of energy)		
	Children, 1–3 y	Children, 4–18 y	Adults
Fat	30–40	25–35	20–35
n-6 polyunsaturated fatty acids*a* (linoleic acid)	5–10	5–10	5–10
n-3 polyunsaturated fatty acids*a* (α-linolenic acid)	0.6–1.2	0.6–1.2	0.6–1.2
Carbohydrate	45–65	45–65	45–65
Protein	5–20	10–30	10–35

a Approximately 10% of the total can come from longer-chain *n*-3 or *n*-6 fatty acids.

SOURCE: *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids* (2002).

Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals, Vitamins

Life Stage Group	Vit A (µg/d)[a]	Vit C (mg/d)	Vit D (µg/d)[b,c]	Vit E (mg/d)[d]	Vit K (µg/d)	Thiamin (mg/d)	Riboflavin (mg/d)	Niacin (mg/d)[e]	Vit B_6 (mg/d)	Folate (µg/d)[f]	Vit B_{12} (µg/d)	Pantothenic Acid (mg/d)	Biotin (µg/d)	Choline[g] (mg/d)
Infants														
0–6 mo	400*	40*	5*	4*	2.0*	0.2*	0.3*	2*	0.1*	65*	0.4*	1.7*	5*	125*
7–12 mo	500*	50*	5*	5*	2.5*	0.3*	0.4*	4*	0.3*	80*	0.5*	1.8*	6*	150*
Children														
1–3 y	300	15	5*	6	30*	0.5	0.5	6	0.5	150	0.9	2*	8*	200*
4–8 y	400	25	5*	7	55*	0.6	0.6	8	0.6	200	1.2	3*	12*	250*
Males														
9–13 y	600	45	5*	11	60*	0.9	0.9	12	1.0	300	1.8	4*	20*	375*
14–18 y	900	75	5*	15	75*	1.2	1.3	16	1.3	400	2.4	5*	25*	550*
19–30 y	900	90	5*	15	120*	1.2	1.3	16	1.3	400	2.4	5*	30*	550*
31–50 y	900	90	5*	15	120*	1.2	1.3	16	1.3	400	2.4	5*	30*	550*
51–70 y	900	90	10*	15	120*	1.2	1.3	16	1.7	400	2.4*i*	5*	30*	550*
> 70 y	900	90	15*	15	120*	1.2	1.3	16	1.7	400	2.4*i*	5*	30*	550*
Females														
9–13 y	600	45	5*	11	60*	0.9	0.9	12	1.0	300	1.8	4*	20*	375*
14–18 y	700	65	5*	15	75*	1.0	1.0	14	1.2	400*i*	2.4	5*	25*	400*
19–30 y	700	75	5*	15	90*	1.1	1.1	14	1.3	400*i*	2.4	5*	30*	425*
31–50 y	700	75	5*	15	90*	1.1	1.1	14	1.3	400*i*	2.4	5*	30*	425*
51–70 y	700	75	10*	15	90*	1.1	1.1	14	1.5	400	2.4*h*	5*	30*	425*
> 70 y	700	75	15*	15	90*	1.1	1.1	14	1.5	400	2.4*h*	5*	30*	425*
Pregnancy														
14–18 y	750	80	5*	15	75*	1.4	1.4	18	1.9	600*j*	2.6	6*	30*	450*
19–30 y	770	85	5*	15	90*	1.4	1.4	18	1.9	600*j*	2.6	6*	30*	450*
31–50 y	770	85	5*	15	90*	1.4	1.4	18	1.9	600*j*	2.6	6*	30*	450*
Lactation														
14–18 y	1,200	115	5*	19	75*	1.4	1.6	17	2.0	500	2.8	7*	35*	550*
19–30 y	1,300	120	5*	19	90*	1.4	1.6	17	2.0	500	2.8	7*	35*	550*
31–50 y	1,300	120	5*	19	90*	1.4	1.6	17	2.0	500	2.8	7*	35*	550*

NOTE:

This table (taken from the DRI reports, see www.nap.edu) presents Recommended Dietary Allowances (RDAs) in **bold type** and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover needs of all ndividuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

*a*As retinol activity equivalents (RAEs). 1 RAE = 1 mg retinol, 12 mg b-carotene, 24 mg a-carotene, or 24 mg b-cryptoxanthin. The RAE for dietary provitamin A carotenoids is twofold greater than retinol equivalents (RE), whereas the RAE for reformed vitamin A is the same as RE.

*b*As cholecalciferol. 1 µg cholecalciferol = 40 IU vitamin D.

*c*In the absence of adequate exposure to sunlight.

*d*As a-tocopherol. a-Tocopherol includes *RRR*-a-tocopherol, the only form of a-tocopherol that occurs naturally in foods, and the *2R*-stereoisomeric forms of a-tocopherol (*RRR-*, *RSR-*, *RRS-*, and *RSS*-a-tocopherol) that occur in fortified foods and supplements. It does not include the *2S*-stereoisomeric forms of a-tocopherol (*SRR-*, *SSR-*, *SRS-*, and *SSS*-a-tocopherol), also found in fortified foods and supplements.

*e*As niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan; 0–6 months = preformed niacin (not NE).

f As dietary folate equivalents (DFE). 1 DFE = 1 µg food folate = 0.6 µg of folic acid from fortified food or as a supplement consumed with food = 0.5 µg of a supplement taken on an empty stomach.

g Although AIs have been set for choline, there are few data to assess whether a dietary supply of choline is needed at all stages of the life cycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages.

*h*Because 10 to 30 percent of older people may malabsorb food-bound B12, it is advisable for those older than 50 years to meet their RDA mainly by consuming foods fortified with B12 or a supplement containing B12.

*i*In view of evidence linking folate intake with neural tube defects in the fetus, it is recommended that all women capable of becoming pregnant consume 400 µg from supplements or fortified foods in addition to intake of food folate from a varied diet.

*j*It is assumed that women will continue consuming 400 µg from supplements or fortified food until their pregnancy is confirmed and they enter prenatal care, which ordinarily occurs after the end of the periconceptional period—the critical time for formation of the neural tube.

Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals, Elements

Life Stage Group	Calcium (mg/d)	Chromium (µg/d)	Copper (µg/d)	Fluoride (mg/d)	Iodine (µg/d)	Iron (mg/d)	Magnesium (mg/d)	Manganese (mg/d)	Molybdenum (µg/d)	Phosphorus (mg/d)	Selenium (µg/d)	Zinc (mg/d)	Potassium (g/d)	Sodium (g/d)	Chloride (g/d)
Infants															
0–6 mo	210*	0.2*	200*	0.01*	110*	0.27*	30*	0.003*	2*	100*	15*	2*	0.4*	0.12*	0.18*
7–12 mo	270*	5.5*	220*	0.5*	130*	**11**	75*	0.6*	3*	275* *	20*	**3**	0.7*	0.37	0.57*
Children															
1–3 y	500*	11*	**340**	0.7*	**90**	**7**	**80**	1.2*	**17**	**460**	**20**	**3**	3.0*	1.0*	1.5*
4–8 y	800*	15*	**440**	1*	**90**	**10**	**130**	1.5*	**22**	**500**	**30**	**5**	3.8*	1.2*	1.9*
Males															
9–13 y	1,300*	25*	**700**	2*	**120**	**8**	**240**	1.9*	**34**	**1,250**	**40**	**8**	4.5*	1.5*	2.3*
14–18 y	1,300*	35*	**890**	3*	**150**	**11**	**410**	2.2*	**43**	**1,250**	**55**	**11**	4.7*	1.5*	2.3*
19–30 y	1,000*	35*	**900**	4*	**150**	**8**	**400**	2.3*	**45**	**700**	**55**	**11**	4.7*	1.5*	2.3*
31–50 y	1,000*	35*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**	4.7*	1.5*	2.3*
51–70 y	1,200* *	30*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**	4.7*	1.3*	2.0
> 70 y	1,200* *	30*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**	4.7*	1.2	1.8*
Females															
9–13 y	1,300*	21*	**700**	2*	**120**	**8**	**240**	1.6*	**34**	**1,250**	**40**	**8**	4.5*	1.5*	2.3*
14–18 y	1,300*	24*	**890**	3*	**150**	**15**	**360**	1.6*	**43**	**1,250**	**55**	**9**	4.7*	1.5*	2.3*
19–30 y	1,000*	25*	**900**	3*	**150**	**18**	**310**	1.8*	**45**	**700**	**55**	**8**	4.7*	1.5*	2.3*
31–50 y	1,000*	25*	**900**	3*	**150**	**18**	**320**	1.8*	**45**	**700**	**55**	**8**	4.7*	1.5*	2.3*
51–70 y	1,200*	20*	**900**	3*	**150**	**8**	**320**	1.8*	**45**	**700**	**55**	**8 4.**	7*	1.3*	2.0*
> 70 y	1,200*	20*	**900**	3*	**150**	**8** *	**320**	1.8*	**45**	**700**	**55**	**8 4.**	7*	1.2	1.8*
Pregnancy															
14–18 y	1,300*	29*	**1,000**	3*	**220**	**27**	**400**	2.0*	**50**	**1,250**	**60**	**12**	4.7*	1.5*	2.3*
19–30 y	1,000* *	30*	**1,000**	3*	**220**	**27**	**350**	2.0*	**50**	**700**	**60**	**11**	4.7*	1.5*	2.3
31–50 y	1,000*	30*	**1,000**	3*	**220**	**27**	**360**	2.0*	**50**	**700**	**60**	**11**	4.7*	1.5*	2.3*
Lactation															
14–18 y	1,300*	44*	**1,300**	3*	**290**	**10**	**360**	2.6*	**50**	**1,250**	**70**	**13**	5.1*	1.5*	2.3*
19–30 y	1,000*	45*	**1,300**	3*	**290**	**9**	**310**	2.6*	**50**	**700**	**70**	**12**	5.1*	1.5*	2.3*
31–50 y	1,000*	45*	**1,300**	3*	**290**	**9**	**320**	2.6*	**50**	**700**	**70**	**12**	5.1*	1.5*	2.3*

NOTE:
This table presents Recommended Dietary Allowances (RDAs) in **bold type** and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001); and *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate* (2004). These reports may be accessed via http://www.nap.edu.

Dietary Reference Intakes (DRIs): Tolerable Upper Intake Levels (UL[a]), Vitamins

Food and Nutrition Board, Institute of Medicine, National Academies

Life Stage Group	Vitamin A (μg/d)[b]	Vitamin C (mg/d)	Vitamin D (μg/d)	Vitamin E (mg/d)[c,d]	Vitamin K	Thiamin	Riboflavin	Niacin (mg/d)[d]	Vitamin B_6 (mg/d)	Folate (μg/d)[d]	Vitamin B_{12}	Pantothenic Acid	Biotin	Choline (g/d)	Carotenoids[e]
Infants															
0–6 mo	600	ND[f]	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7–12 mo	600	ND	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Children															
1–3 y	600	400	50	200	ND	ND	ND	10	30	300	ND	ND	ND	1.0	ND
4–8 y	900	650	50 3	00	ND	ND	ND	15	40	400	ND	ND	ND	1.0	ND
Males, Females															
9–13 y	1,700	1,200	50	600	ND	ND	ND	20	60	600	ND	ND	ND	2.0	ND
14–18 y	2,800	1,800	50	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–70 y	3,000	2,000	50	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
> 70 y	3,000	2,000	50	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
Pregnancy															
14–18 y	2,800	1,800	50	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–50 y	3,000	2,000	50	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
Lactation															
14–18 y	2,800	1,800	50	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–50 y	3,000	2,000	50	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND

a UL = The maximum level of daily nutrient intake that is likely to pose no risk of adverse effects. Unless otherwise specified, the UL represents total intake from food, water, and supplements. Due to lack of suitable data, ULs could not be established for vitamin K, thiamin, riboflavin, vitamin B12, pantothenic acid, biotin, carotenoids. In the absence of ULs, extra caution may be warranted in consuming levels above recommended intakes.

b As preformed vitamin A only.

c As α-tocopherol; applies to any form of supplemental α-tocopherol.

d The ULs for vitamin E, niacin, and folate apply to synthetic forms obtained from supplements, fortified foods, or a combination of the two.

e β-Carotene supplements are advised only to serve as a provitamin A source for individuals at risk of vitamin A deficiency.

f ND = Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high levels of intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); and *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron,Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001). These reports may be accessed via http://www.nap.edu.

Dietary Reference Intakes (DRIs): Tolerable Upper Intake Levels (UL[a]), Elements

Food and Nutrition Board, Institute of Medicine, National Academies

Life Stage Group	Arsenic [b]	Boron (mg/d)	Calcium (g/d)	Chromium	Copper (μg/d)	Fluoride (mg/d)	Iodine (μg/d)	Iron (mg/d)	Magnesium (mg/d)[c]	Manganese (mg/d)	Molybdenum (μg/d)	Nickel (mg/d)	Phosphorus (g/d)	Potassium	Selenium (μg/d)	Silicon [d]	Sulfate	Vanadium (mg/d)[e]	Zinc (mg/d)	Sodium (g/d)	Chloride (g/d)
Infants																					
0–6 mo	ND[f]	ND	ND	ND	ND	0.7	ND	40	ND	ND	ND	ND	ND	ND	45	ND	ND	ND	4	ND	ND
7–12 mo	ND	ND	ND	ND	ND	0.9	ND	40	ND	ND	ND	ND	ND	ND	60	ND	ND	ND	5	ND	ND
Children																					
1–3 y	ND	3	2.5	ND	1,000	1.3	200	40	65	2	300	0.2	3	ND	90	ND	ND	ND	7	5	2.3
4–8 y	ND	6	2.5	ND	3,000	2.2	300	40	110	3	600	0.3	3	ND	150	ND	ND	ND	12	1.9	2.9
Males, Females																					
9–13 y	ND	11	2.5	ND	5,000	10	600	40	350	6	1,100	0.6	4	ND	280	ND	ND	ND	23	2.2	3.4
14–18 y	ND	17	2.5	ND	8,000	10	900	45	350	9	1,700	1.0	4	ND	400	ND	ND	ND	34	2.3	3.6
19–70 y	ND	20	2.5	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	ND	400	ND	ND	1.8	40	2.3	3.6
> 70 y	ND	20	2.5	ND	10,000	10	1,100	45	350	11	2,000	1.0	3	ND	400	ND	ND	1.8	40	2.3	3.6
Pregnancy																					
14–18 y	ND	17	2.5	ND	8,000	10	900	45	350	9	1,700	1.0	3.5	ND	400	ND	ND	ND	34	2.3	3.6
19–50 y	ND	20	2.5	ND	10,000	10	1,100	45	350	11	2,000	1.0	3.5	ND	400	ND	ND	ND	40	2.3	3.6
Lactation																					
14–18 y	ND	17	2.5	ND	8,000	10	900	45	350	9	1,700	1.0	4	ND	400	ND	ND	ND	34	2.3	3.6
19–50 y	ND	20	2.5	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	ND	400	ND	ND	ND	40	2.3	3.6

a UL = The maximum level of daily nutrient intake that is likely to pose no risk of adverse effects. Unless otherwise specified, the UL represents total intake from food, water, and supplements. Due to lack of suitable data, ULs could not be established for arsenic, chromium, silicon, potassium, and sulfate. In the absence of ULs, extra caution may be warranted in consuming levels above recommended intakes.

b Although the UL was not determined for arsenic, there is no justification for adding arsenic to food or supplements.

c The ULs for magnesium represent intake from a pharmacological agent only and do not include intake from food and water.

d Although silicon has not been shown to cause adverse effects in humans, there is no justification for adding silicon to supplements.

e Although vanadium in food has not been shown to cause adverse effects in humans, there is no justification for adding vanadium to food and vanadium supplements should be used with caution. The UL is based on adverse effects in laboratory animals and this data could be used to set a UL for adults but not children and adolescents.

f ND = Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high levels of intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001); and *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate* (2004). These reports may be accessed via http://www.nap.edu.

Dietary Reference Intakes (DRIs): Estimated Average Requirements for Groups

Food and Nutrition Board, Institute of Medicine, National Academies

Life Stage Group	CHO (g/d)	Protein (g/d)*a*	Vit A (µg/d)*b*	Vit C (mg/d)	Vit E (mg/d)*c*	Thiamin (mg/d)	Riboflavin (mg/d)	Niacin (mg/d)*d*	Vit B6 (mg/d)	Folate (µg/d)*b*	Vit B12 (µg/d)	Copper (µg/d)	Iodine (µg/d)	Iron (mg/d)	Magnesium (mg/d)	Molybdenum (µg/d)	Phosphorus (mg/d)	Selenium (µg/d)	Zinc (mg/d)
Infants																			
7–12 mo		9*												6.9					2.5
Children																			
1–3 y	100	11	210	13	5	0.4	0.4	5	0.4	120	0.7	260	65	3.0	65	13	380	17	2.5
4–8 y	100	15	275	22	6	0.5	0.5	6	0.5	160	1.0	340	65	4.1	110	17	405	23	4.0
Males																			
9–13 y	100	27	445	39	9	0.7	0.8	9	0.8	250	1.5	540	73	5.9	200	26	1,055	35	7.0
14–18 y	100	44	630	63	12	1.0	1.1	12	1.1	330	2.0	685	95	7.7	340	33	1,055	45	8.5
19–30 y	100	46	625	75	12	1.0	1.1	12	1.1	320	2.0	700	95	6	330	34	580	45	9.4
31–50 y	100	46	625	75	12	1.0	1.1	12	1.1	320	2.0	700	95	6	350	34	580	45	9.4
51–70 y	100	46	625	75	12	1.0	1.1	12	1.4	320	2.0	700	95	6	350	34	580	45	9.4
> 70 y	100	46	625	75	12	1.0	1.1	12	1.4	320	2.0	700	95	6	350	34 5	80	45	9.4
Females																			
9–13 y	100	28	420	39	9	0.7	0.8	9	0.8	250	1.5	540	73	5.7	200	26	1,055	35	7.0
14–18 y	100	38	485	56	12	0.9	0.9	11	1.0	330	2.0	685	95	7.9	300	33	1,055	45	7.3
19–30 y	100	38	500	60	12	0.9	0.9	11	1.1	320	2.0	700	95	8.1	255	34	580	45	6.8
31–50 y	100	38	500	60	12	0.9	0.9	11	1.1	320	2.0	700	95	8.1	265	34	580	45	6.8
51–70 y	100	38	500	60	12	0.9	0.9	11	1.3	320	2.0	700	95	5	265	34	580	45	6.8
> 70 y	100	38	500	60	12	0.9	0.9	11	1.3	320	2.0	700	95	5	265	34	580	45	6.8
Pregnancy																			
14–18 y	135	50	530	66	12	1.2	1.2	14	1.6	520	2.2	785	160	23	335	40	1,055	49	10.5
19–30 y	135	50	550	70	12	1.2	1.2	14	1.6	520	2.2	800	160	22	290	40	580	49	9.5
31–50 y	135	50	550	70	12	1.2	1.2	14	1.6	520	2.2	800	160	22	300	40	580	49	9.5
Lactation																			
14–18 y	160	60	885	96	16	1.2	1.3	13	1.7	450	2.4	985	209	7	300	35	1,055	59	10.9
19–30 y	160	60	900	100	16	1.2	1.3	13	1.7	450	2.4	1,000	209	6.5	255	36	580	59	10.4
31–50 y	160	60	900	100	16	1.2	1.3	13	1.7	450	2.4	1,000	209	6.5	265	36	580	59	10.4

NOTE: This table presents Estimated Average Requirements (EARs), which serve two purposes: for assessing adequacy of population intakes, and as the basis for calculating Recommended Dietary Allowances (RDAs) for individuals for those nutrients. EARs have not been established for vitamin D, vitamin K, pantothenic acid, biotin, choline, calcium, chromium, fluoride, manganese, or other nutrients not yet evaluated via the DRI process.

a For individual at reference weight (Table 1-1). *indicates change from prepublication copy due to calculation error.

b As retinol activity equivalents (RAEs). 1 RAE = 1 µg retinol, 12 µg β-carotene, 24 µg α-carotene, or 24 µg β-cryptoxanthin. The RAE for dietary provitamin A carotenoids is two-fold greater than retinol equivalents (RE), whereas the RAE for preformed vitamin A is the same as RE.

c As α-tocopherol. α-Tocopherol includes *RRR*-α-tocopherol, the only form of α-tocopherol that occurs naturally in foods, and the *2R*-stereoisomeric forms of α-tocopherol (*RRR-*, *RSR-*, *RRS-*, and *RSS*-α-tocopherol) that occur in fortified foods and supplements. It does not include the *2S*-stereoisomeric forms of α-tocopherol (*SRR-*, *SSR-*, *SRS-*, and *SSS*-α-tocopherol), also found in fortified foods and supplements.

d As niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan.

e As dietary folate equivalents (DFE). 1 DFE = 1 µg food folate = 0.6 µg of folic acid from fortified food or as a supplement consumed with food = 0.5 µg of a supplement taken on an empty stomach.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001), and *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids* (2002). These reports may be accessed via www.nap.edu.