

Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics



Bachelor Thesis

**Scarcity of Natural Resources with Focus on Water in
Vietnam**

Kim Anh Nguyen

© 2018 CULS Prague

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

Kim Anh Nguyen

Business Administration

Thesis title

Scarcity of Natural Resources – Focus on Water in Vietnam

Objectives of thesis

The qualification work is intended for the investigation of the scarcity of fresh water resources in the world and formulate the solution to improve the situation in Vietnam.

The purpose of the research is to analyse the situation of the lack of fresh water in the world, and through it, showing how the government and people in Vietnam solve this problem for their life, particularly in agriculture – an agricultural country, in order to clearly see the important of fresh water in our life.

To understand clearly about water resources, giving the general evaluation of global water resources. To find out the role of water resources for humans, organism and production for human life. Describe the global problem: the scarcity of fresh water. To study the water resources protection systems in developed country around the world, then expand, compare and apply on Vietnam.

Methodology

The thesis will contain descriptive and comparative methods and logical inference methods. The Methodology includes: theoretical part and practical part. The theoretical part focuses on the role, present condition, situation of water resources. And also the scarcity of water resources in human life, especially economics in the world. In addition, there are some protective and improvable measures water resources. The practical part will focuses on water scarcity in Vietnam, particularly the deterioration of water resources in river basins. Besides of that, it also has the role of water resources for living, agriculture and industry; the structure of water consumption: water supply, water demand, freshwater price in Vietnam and how the government and people in Vietnam protect the water resources.

The proposed extent of the thesis

35 – 40 pages

Keywords

Scarcity, Natural Resources , water , Vietnam, solutions

Recommended information sources

Barlow M. Blue Covenant. The Global Water Crisis and the Coming Battle for the Right to water. New York, London: The New Press, 2007
Barnett, H. Morse, C.: Scarcity and Growth: The economics and natural Resources Scarcity. Baltimore, Johns Hopkins Press, 1963
HUSTED, S. *International economics*. Boston: Pearson Addison Wesley, 2007. ISBN 0321451228.

Expected date of thesis defence

2017/18 SS – FEM

The Bachelor Thesis Supervisor

doc. Ing. Mansoor Maitah, Ph.D. et Ph.D.

Supervising department

Department of Economics

Electronic approval: 12. 3. 2018

prof. Ing. Miroslav Svatoš, CSc.

Head of department

Electronic approval: 12. 3. 2018

Ing. Martin Pelikán, Ph.D.

Dean

Prague on 13. 03. 2018

Declaration

I declare that I have worked on my bachelor thesis “Scarcity of Natural Resources with Focus on Water in Vietnam” by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any third person.

In Prague, March 6, 2018

.....

Kim Anh Nguyen

Acknowledgement

I would like to thank my supervisor Assoc. prof. Mansoor Maitah, Ph. D.et Ph.D. and all other persons, for their advice and support during my work on my thesis.

Nedostatek přírodních zdrojů se zaměřením na vodu ve Vietnamu

Souhrn

Tato bakalářská práce pojednává o analýze nedostatku vody a dalších souvislostí tohoto tématu na základě příkladu z Vietnamu.

Teoretická část především popisuje situaci nedostatku vody ve světě, důležitost vodních zdrojů, a jak mezinárodní organizace chrání tyto zdroje. Teoretickým a metodologickým základem této práce jsou projekty ekologů, ekonomů, zákonodárců a mezinárodních organizací, které se zabývají problematikou nedostatku vody. Na příkladu Vietnamu vidíme, že se nedostatek může vyskytnout i v zemi s bohatými přírodními zdroji.

Závěrem je, že snižující se počet vodních zdrojů v povodích řek má neblahý vliv na lidské životy, ekosystémy a ekonomii, jak dokazují výsledky této studie podložené na základě kvalitativních dat a grafů.

Klíčová slova: Nedostatek, přírodní zdroje, voda, Vietnam, řešení.

Scarcity of Natural Resources with Focus on Water in Vietnam

Summary

This bachelor thesis focuses on the analysis of water scarcity and other details of this topic, based on the example of Vietnam.

The theoretical part mainly describes the situation of water scarcity in the world, the significance of water resources and how international organizations protect these resources. Theoretical and methodological basis of this paper is the project of environmentalists, economists, policymakers and international organizations that are working on the problem of water shortage. As shown in example of Vietnam, scarcity can occur even in a country with abundant resources.

Overall, shrinking of water resources in river basins has an adverse effect on human lives, ecosystems and economy, as supported by the results of this study based on qualitative data and graphs.

Keywords: Scarcity, Natural Resources, water, Vietnam, solutions

Table of Contents

Introduction	11
Objectives and Methodology	14
2.1. Objectives.....	14
2.2. Methodology.....	14
Literature review	16
3.1. Distribution of water resources.....	16
3.2. The role of water resources.....	18
3.3. The shortage of water resources in the world.....	19
3.4. Causes of water scarcity.....	22
3.5. Water demand in the world.....	24
3.5.1. Water demand in industry.....	24
3.5.2. Water demand in agriculture.....	25
3.5.3. Water demand for living and entertainment.....	25
3.5.4. Water stress.....	25
3.6. The cost of water of some countries in the world.....	26
3.7. Solutions to protect the water by World Wildlife Fund.....	28
3.8. The economics effects of scarcity.....	29
3.9. Interaction of sources of environment scarcity.....	30
Practical part	33
4.1. The situation of water resources in Vietnam.....	33
4.1.1. Water resources pollution.....	33
4.1.2. The geography and climate of Vietnam.....	34
4.2. Structure of water consumption in Vietnam and water price.....	36
4.2.1. Using of Groundwater.....	36
4.2.2. Using of mineral water and hot water.....	36
4.2.3. Using water in agriculture.....	37
4.2.4. Using water in economic activities.....	38
4.2.5. Using water in daily life.....	39
4.2.6. Water use in database.....	40
4.2.7 Water price.....	42
Results	44
5.1. Policies and legislation.....	44

5.2. Reduction of water resources in river basins	45
5.2.1. Severe decline of water resources in downstream river basins	45
5.2.2. Causes of water degradation in river basins	46
5.2.3. Solutions to reduce water loss in river basins	48
5.3. Solutions to protect water resources	49
5.3.1. Take care of water resources	49
5.3.2. Manage and educate community method	50
5.3.3. Other methods	50
Conclusion	52
List of reference	54

List of Figures

Figure 1 – Water distribution on Earth.	17
Figure 2 – Water withdrawal by sector	41
Figure 3 – Water withdrawal by source	42

List of Tables

Table 1 – The Earth’s water resources	18
Table 2 - World: Population, GDP and Water Withdrawals.....	23
Table 3 – The cost of water of developed nations.....	27
Table 4 – Irrigated crops in full control irrigation schemes	37
Table 5 – Water use in 2005	40
Table 6 – Water price for household.....	43
Table 7 – Water price for offices, production bases and operations	43

List of Schemes

Scheme 1 - Physical and Economic Water Scarcity	21
Scheme 2 – Resource Capture and Ecological Marginalization	31

Introduction

As the world is rapidly developing, the human needs in all its aspects is also increasing, resulting in the rapid exhaustion of the Earth's natural resources. Consequently, the use of natural resources and protection of the environment has become a major issue around the world. Because most natural resources are limited - it only irreversibly decreases day by day, so humankind should use it only for the right and necessary purposes.

Looking back in the history in the past two centuries of industrial revolution, emergence of science and expansion of human population, the concerns with natural resources is being promoted and extended. According to a British classical economics theory from the beginning of 19th Century that a limited availability of natural resources constrains the economic growth and welfare. Secondly, the Conservation Movement in the United States (1890-1920) protected the nation from short-sighted exploitation by rapacious corporations. Because of that, natural resources became important for a long time and has been controlled very strictly. However, it is considered by many, that natural resources have no limit, they can use it forever without saving and protecting it. Some persons with their narrow knowledge, they keep wasting natural resources and some persons who know about the scarcity of natural resources, but they continue to use it too much for their purpose. They cannot understand how our life will be in the future without natural resources. It affects every aspect of our life such as: economics, finance, politics, foreign trade, society...So what is "Scarcity of natural resources?"

Natural resources are the source of original material that is created and exist in the nature that human can exploit, process and use for their production and life. They are the necessary conditions for the existence of human society and an essential part of the environment, closely related to the environment. There are three main types of natural resources: renewable resources, non-renewable resources and permanent energy resources. As S. E. Jorgensen (1981), Renewable resources (fresh water, soil, organisms, etc.) are self-sustaining or self-supplement continuous that are managed appropriately. However, if used unreasonably, renewable resources may be undeveloped. For example, water resources may be contaminated, land resources may be salinized, degraded, eroded, etc. Non-renewable are finite, lost or altered after use. For example, mineral resources of a

mine maybe exhausted after mining. Genetic resources maybe lost away with the extermination of rare species. Permanent energy resources (solar, wind, waves, tides, etc.) have been studied and used increasingly, gradually replacing the exhausted energy and limiting environmental pollution.

In economics, scarcity is an issue where the needs and wants of human are infinite, while resources are finite. In other words, nature cannot have enough natural resources to satisfy all human demands. Scarcity implies that many social goals cannot be pursued at the same time with the same amount of available resources, that trade-off will occur which cause the goal to conflict with another objective. The more important issue is that scarcity always exists because of the inherent conflict between the demand for natural resources and the ability to satisfy demand. This conflict is expressed in the fact that human needs are constantly increasing while the resources are limited.

Water is one of the natural resources, which is severely deficient. Water resources are sources of water that people use for different purposes. Water is used in agriculture, industrial, living, recreational and environmental activities. Most of these activities require fresh water. 97% of water on Earth is salt water, while only 3% is fresh water. But nowadays, water resources are almost exhausted for a variety of reasons and one of the most reasons is human activity. Unreasonable use of water resources has resulted in many serious consequences for the human environment and living things on Earth. That helps people to see the importance of water resources, contributing to raising awareness in protecting water as well as protecting their living environment.

In average, about 2 million tons of domestic waste is eliminated to lakes, rivers and sea, 70% of untreated industrial waste is directly dumped into sources of water in developing country. This is the statistics of the International Water Institute (SIWI) published at the World Water Week opening in Stockholm, the capital of Sweden on 5/9. In fact, the water used in human activities is seriously polluted. Half of patients stays in hospital in developing countries because without using clean water water-related diseases would spread rapidly. Lack of clean water and sanitation is the cause of death of more than 1.6 million children each year. The Food and Agriculture Organization (FAO) warns that in the next 15 years there will be nearly 2 billion people living in water scarce areas and 2/3 population on the planet maybe not have enough fresh water.

Like many countries around the world, Vietnam is also facing with water scarcity, especially in industrial and urban areas. According to estimates by the United Nations International Children's Emergency Fund (UNICEF), about 17 million (52%) of children without using clean water about 20 million (59%) have no sanitary latrines in Vietnam. UNICEF Executive Director Ann M. Veneman said: "Around the world, in every 15 seconds has a child that dies from diseases caused by unclean water and unclean water is the main reason of most diseases and malnutrition. A child growing up in such conditions would have little chance of getting out of poverty."

This paper evaluates current situation of water scarcity in the world and especially in Vietnam. There is a serious degradation of water resources in river basin. Besides that, it also highlights the role of water with human beings, particularly in the economy. From that point, the focus will be on solutions to mitigate and overcome the scarcity.

Based on the data and information that has been calculated, through theoretical and practical part, the goal is to illustrate that lack of fresh water is very complex and serious. Furthermore, the aim is also to understand clearly the situation in Vietnam to protect and preserve fresh water- is on the verge of exhaustion.

Objectives and Methodology

2.1. Objectives

The qualification work is intended for the investigation of the scarcity of fresh water resources in the world and formulate the solution to improve the situation in Vietnam.

The purpose of the research is to analyse the situation of the lack of fresh water in the world, and through it, showing how the government and people in Vietnam solve this problem for their life, particularly in agriculture – an agricultural country, in order to clearly see the importance of fresh water in our life.

Proceeding from this purpose, the following steps are completed in the work:

- To understand clearly water resources, giving the general evaluation of global water resources;
- To find out the role of water resources for humans, organisms and production for human life. Life would be very difficult if there were no water resources;
- To raise awareness of lack of water resources to see the growing problem of water availability around the world;
- Describe the global problem: the scarcity of fresh water;
- Other factors that lead to water scarcity: drought, fresh water pollution, climate change.
- To study the water resources protection systems in developed countries around the world, then expand, compare and apply to Vietnam.
- Showing how the economics influences scarcity of natural resources and basic scarcity models.

2.2. Methodology

An analysis of water scarcity in the context of global climate change and many areas with polluted water, is based on the results obtained by representatives of a number of scientific disciplines, which includes the following issues: institutional economics (in the analysis structure of international organizations active in the field of water management, protection

of wetlands and climate change mitigation), ecological economics (considering the concept of sustainable development), (in research and assessment of the role of innovation in minimizing problems of water scarcity under pollution and climate change) and neoclassical economics with the environment (in the study of the affection of water scarcity to the economic structure, cost and productivity).

Methodological and theoretical investigations of the study included microeconomic research of the water sector of Vietnam, the modelling of water price options, international economic methods and development of macroeconomic and microeconomic. The research is also based on the theory of creative processes within the framework of business theory, as well as on aggregate economic study, including the analytical and general theory of the nature, role and structure of innovation factor in the economy. The author also gives specific examples to clarify economic studies, helping readers understand more about this issues.

When analysing the paper, the author used the studies of scientists from many scientific groups such as: United National Children’s Emergency Fund, World Wildlife Fund, World Resources Institutes, World Health Organisation and International Monetary Fund. And some statistical data from websites of Nestle Company, Asian Development Bank, the University of Agriculture-Forestry of HCM city in Vietnam...In addition, knowledge of economics with natural scarcity from the book “Scarcity & Growth: The Economics of Natural Resources Availability” of Harold J. Barnett and Chandler Morse. And more other important information from Ministry of Natural Resources and Environment of Vietnam, The National Water Resources Council, the River Basin Management Board and water resources law of the government of Vietnam.

Literature review

Before starting own research, the author would like to show some scientific studies in books or on the internet to describe the awareness of this issue. Theoretical and methodological basis of this paper is the project of environmentalists, economists, policymakers and international organisation from many countries in the world, who are interested in the scarcity of natural resources, especially water resources: Miller (1988), M. I. L'vovich, Sokolov (1974), F. Sargent (1974), Cao Liem- Tran Duc Vien (1990), FAO, UNICEF, WHO and others.

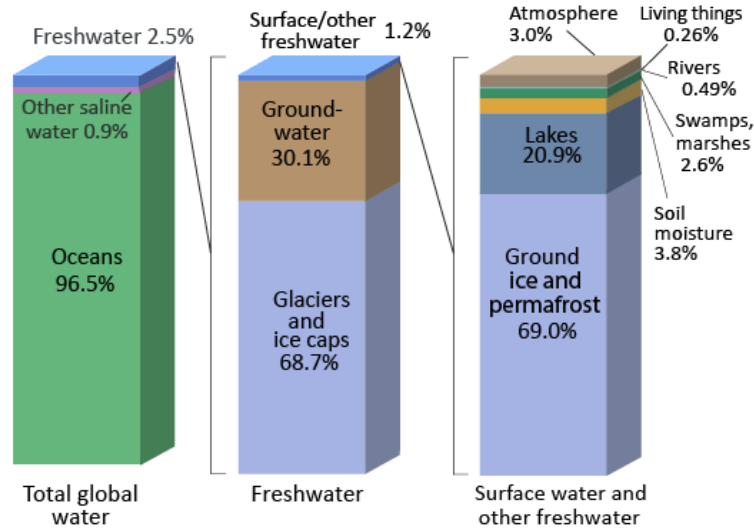
3.1. Distribution of water resources

General introduction of water resources and the proportion of water types in the world (Miller, 1988). Water covers 71% of earth's surface, of which 97% is saltwater, the rest is fresh water. Water keeps the climate relatively stable and dilutes environmental pollutants. It is also a main structural component in organism of living thing. Example: Water takes 70% in human body weight and for jellyfish is 97%. In 3% of the fresh water available on the earth, there are more than $\frac{3}{4}$ of the water that human cannot use because it is so deep in the ground, or frozen, or in the atmosphere and in the form of snow on continent. Only 0.5% of fresh water is presented in river, streams, ponds and lakes that human have been using. However, if except for contaminated water, there is only 0.003% of fresh water that can be used by human and by calculation, on average, 897,000 liters of fresh water is used per person. ¹

¹ Shelton, L.R., and Miller, L.K., 1988, Water-quality data, San Joaquin Valley, California, March 1985 to March 1987: U.S. Geological Survey Open-File Report 88-479, 210p.

Figure 1 – Water distribution on Earth.

Where is Earth's Water?



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, *Water in Crisis: A Guide to the World's Fresh Water Resources*.
NOTE: Numbers are rounded, so percent summations may not add to 100.

Source: Conversable economist

According to current knowledge, water on our planet comes from three sources: mainly in the ground, from extraterrestrial meteors bring to and from the upper atmosphere. Water originates in the ground, formed in the middle shell of the earth due to the differentiation of the layers of lava at high temperatures, then escapes by the cracks of the outer shell. It becomes vapours, evaporates and eventually condenses into liquid form and falls to the ground. On the surface, water flows from high to low area and floods the hollows that create the vast oceans and primitive lakes and rivers. According to the calculations, the free water mass over the earth is about 1.4 billion km³, but compared with the water content in the middle shell of the earth (about 200 billion km³), it is not significant because it only accounted for less than 1%. The total amount of natural water in the world is estimated differently by researchers and ranges from 1,385,885,000 km³ (L'vovich, Sokolov – 1974) to 1,457,802,450 km³ (F. Sargent – 1974).²³

² Recent Studies in Bioclimatology. Edited by F.Sargent, II, and R. G. Stone. October, 1974, ISBN 0-933876-03-3.

³ General Hydrogeology. Edited by E. V. Pinneker, Cambridge University Press, 1983, ISBN 978-0-521-15483-3.

Table 1 – The Earth’s water resources

Types of water	Volume (x10³ km³)
Sea and ocean	1 338 000
Ice and snow	24 042.1
Groundwater	23 400 ^a
River channels	2.12
Lakes	176.4
Marshes	10.3
Atmosphere	12.9
In living organisms	1.12
Total (rounded off)	1 385 600

Note: ^a: Not including groundwater in the Antarctic, which is estimated to be 2000km³.
Source: General Hydrogeology book, Sokolov (1974), p.21

Water is a very important resource for all living things on earth. Without water, there would be no life on earth. Lack of water, the current civilization does not exist. In the past, people have known the necessary role of water. Ancient scientists considered water to be the fundamental component of matter. In the course of the development of human society, great civilizations of mankind appear and develop in the basins of large rivers such as the Mesopotamian civilization in West Asia located in the basin of two rivers are Tigre and Euphrate (now belong to Iraq), Egyptian civilization downstream of the Nile, the Ganges civilization in India, the civilization of Huang He in China, Red River civilization in Vietnam,...etc.

3.2. The role of water resources

From 3000 B.C, the Egyptians have already known how to use irrigation systems to grow crops, and today more and more people are discovering the possibilities of water to ensure the future of society. Water is a good source of food and industrial ingredients. It is very important in agriculture, industry, life, sports, entertainment and many other human activities. In addition, water is considered a special mineral because it possesses a large source of energy and dissolves many substances that can be exploited to serve human needs.

Water is especially important to the human body. People can go without food for a few days, but they cannot go without water. Water accounts for about 70% of body weight, 65-

75% of muscle mass, 50% of fat, 50% of bone mass. Water exists in two forms: water within cells and outside cells. Water outside cells is found in blood plasma, saliva and so on. Blood plasma takes for about 20% of body fluids (3-4 liters). Water is significant for chemical reactions and metabolism to incessantly occur in the body. Water is a solvent, so all nutrients are put into the body and then transferred to the blood in aqueous solution. A person weighs 60kg that should provide 2-3 liters of water to renew his/her body's water and maintain normal activity. (Nestle Waters – The Healthy Hydrating Company) ⁴

Drinking not enough water affects the functioning of the cell as well as the functioning of the body's systems, such as impaired renal function. Those who drink not enough water, would have dry skin, brittle hair, fatigue, headache, constipation, kidney stones and gall bladder stone. When the body loses more than 10% of water, it can cause cardiovascular collapse, low blood pressure, high heart rate. More dangerous, you can die if the water loss is over 20%. Besides oxygen, water has a second important role in maintaining life. (Nestle Water) ⁵

In short, water is needed for the body. Everybody has to practice drinking water as a habit, so that the body is not dehydrated. Identify the body's lack of water through the feeling of thirst or colour of the urine, dark yellow urine indicates that the body is dehydrated. Maintaining your body in a state of water balance is an important factor in ensuring your health.

3.3. The shortage of water resources in the world

According to World Wildlife Fund (WWF), "As a result, some 1.1 billion people worldwide lack access to water, and a total of 2.7 billion find water scarce for at least one month of the year. Inadequate sanitation is also a problem for 2.4 billion people - they are exposed to diseases, such as cholera and typhoid fever, and other water-borne illnesses. Two million people, mostly children, die each year from diarrheal diseases alone". ⁶

Statistics from UNICEF in South and East Asia show that water quality in this area is becoming a major threat to children. The arsenic and fluoride pollution in groundwater is

⁴ Nestle Waters – The Healthy Hydrating Company: main functions of water in the human body. <https://www.nestle-waters.com/healthy-hydration/water-fonctions-in-human-body>

⁵ Nestle Waters – The Healthy Hydrating Company: How much water is in the human body <https://www.nestle-waters.com/healthy-hydration/water-body>

⁶ World Wildlife Fund – Water Scarcity: Overview. <https://www.worldwildlife.org/threats/water-scarcity>

seriously threatening the health of 50 million people in the area. At the World Children's Forum in Mexico on March 21, UNICEF said that 400 million children in the world are struggling with life because they do not have access to clean water. Accordingly, children have to pay the highest price when they do not have access to clean water. Research results shows that children under 5 years old are most prone to diarrhoea (which causes 4500 children deaths per day).⁷

“Many of the water systems that keep ecosystems thriving and feed a growing human population have become stressed. Rivers, lakes and aquifers are drying up or becoming too polluted to use. More than half the world’s wetlands have disappeared. Agriculture consumes more water than any other source and wastes much of that through inefficiencies. Climate change is altering patterns of weather and water around the world, causing shortages and droughts in some areas and floods in others.” (WWF)

Many large water sources are used to supply water to a massive area, which has run out. There are some famous environmental disasters about water resources such as: Lake Chad, the Colorado River, the Aral Sea, the Dead Sea (Danilov - Danylan, Losev, 2008).⁸

The Mississippi River, the second longest river in the United States, is 3,782km (3,420miles), originating from Lake Itasca, which flows through Minnesota and Louisiana. The Mississippi River water level dropped to 22% between 1960 and 2004. This decline is linked to climate change and has a serious impact on millions of people around the world. Follow to World Ocean Review, this river is becoming depleted, affecting millions of people and damaging life in the river basin. If this river “dies”, millions of people will lose their livelihoods. Biodiversity is destroyed in a large scale. Fresh water is severely deficient and threatens food security. Recognizing the important of this river, the United States has built thousands of dams and dikes along the length of the river throughout the last century to support water navigation and control flood.⁹

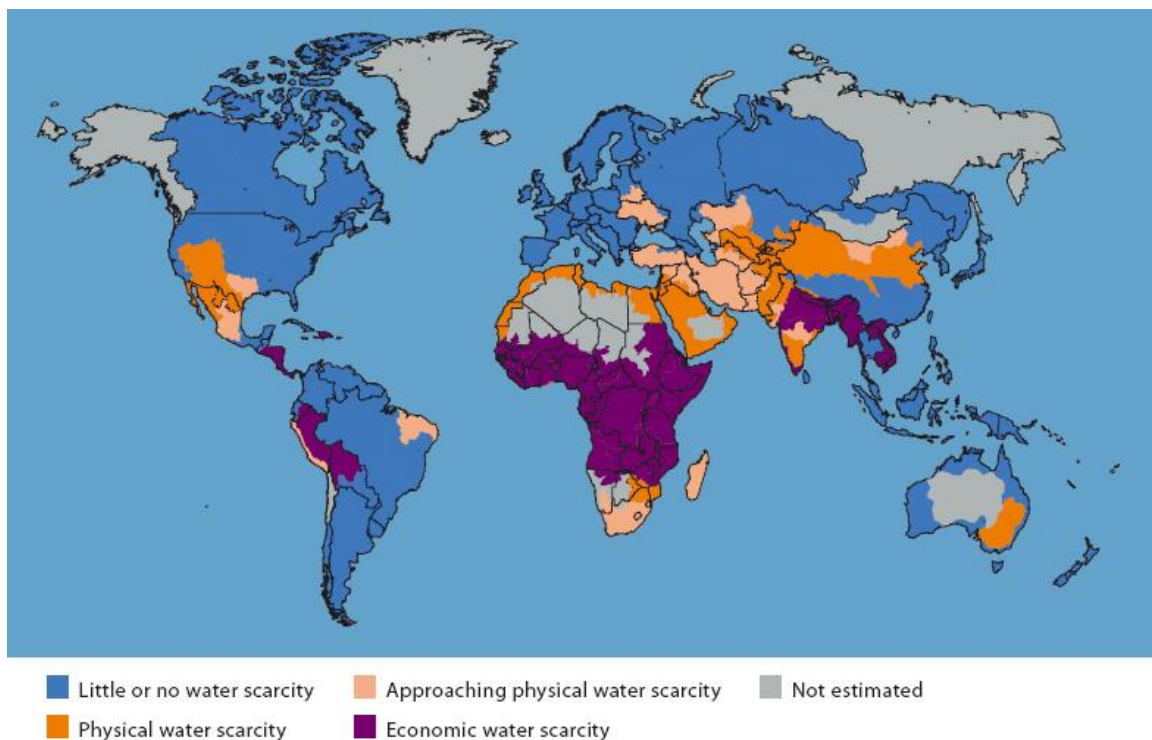
⁷ UNICEF: The United Nations Children’s Emergency Fund. Common water and sanitation-related diseases. https://www.unicef.org/wash/index_wes_related.html

⁸ Danilov-Danilyan V.I., Losev K.S. Water consumption: ecological, economic, social and political aspects. - Moscow: Nauka, 2008. - 221 p.

⁹ The Mississippi River and the Gulf of Mexico dead zone. <https://worldoceanreview.com/en/wor-1/pollution/over-fertilization/the-mississippi-river-and-the-gulf-of-mexico-dead-zone/>

The Yellow River (Huang He), which is the second longest river in China, has a very important role for the people in this country. This is the largest source of water for millions of people in Northern China but now which is severely polluted by oil spills and industrial wastes. A broken oil pipeline from the China National Petroleum Corporation with more than 1,500 liters of oil spilled into farmland and a tributary of the Yellow River (Hays, 2009).¹⁰

Scheme 1 - Physical and Economic Water Scarcity



Source: Water Resources Institutes. Making big Idea happen.

As you can see in scheme 1, the world is running out of fresh water. The pink – the area with approaching physical water scarcity. The orange – the area with physical water scarcity. And the purple, large amount – the area with economic water scarcity. Freshwater is a renewable resource, but the supply of fresh water in the world is gradually decreasing. Water demand has surpassed water supply in some parts of the world, while the world’s population continues to increase, increasing the demand for water. Awareness of the importance of water protection for ecosystem needs has only recently been raised.

¹⁰ Water pollution in China. <http://factsanddetails.com/china/cat10/sub66/item391.html>

Throughout the 20th century, more than half the world's wetlands have disappeared along with their valuable supportive environments. Biodiversity freshwater ecosystems are declining faster than marine and terrestrial ecosystems. The world's water ecosystems face formidable threats. More than a billion people currently live in water-scarce regions, and as 3.5 billion could experience water scarcity by 2025. (World Resources Institutes - 2009) ¹¹

At least 80 countries in the desert and semi-desert (about 40% of the world's population) in Asia and Africa continually suffer droughts and poor harvests so they do not provide enough food for their life. In the 1970s, the drought threatened about 24.4 million people and killed more than 23 million people every year, the consequences of which continued until 1980. In 1985, more than 154 million people in 21 African countries were affected by drought. Because of the excessive population growth and widespread wars, on the other hand, the ineffective management, use of resources and agriculture development led to this. In these countries, poor people spend a lot of time looking for fresh water, often in contaminated rivers and streams. And to get fresh water, the woman and children must walk between 16km to 25km one day but only can carry a bottle of water on the way back (Miller, 1988). ¹²

Long drought in Yunnan province, China has dried up 273 rivers, 413 reservoirs and left 3.19 million people and 1.58 million livestock in severe water shortages.

3.4. Causes of water scarcity

Causes of water scarcity (WWF). There are four main causes of water scarcity: pollution, agriculture, population growth and climate change.

Water pollution comes from many reasons including pesticides, fertilizers discharged from the farm, untreated human wastes and industrial waste. Even groundwater is polluted by pollutants leach into underground aquifers. According to the World Health Organisation (WHO), it is estimated that in underdeveloped countries, 70% of people in suburban areas and 25% people in cities do not have enough freshwater to use.

¹¹ World Resources Institutes. Water: Mapping, measuring, and mitigating global water challenges. <http://www.wri.org/our-work/topics/water>

¹² Climate change and Food Security in West Asia and North Africa book. Editor by Mannava V.K. Sivakumar, 2013. ISBN: 978-94-007-6750-8.

“Agriculture use 70% of the world accessible fresh water, but some 60% of this is wasted due to leaky irrigation systems, inefficient application methods as well as the cultivation of crops that are too thirsty for the environment in which they are grown. This wasteful use of water is drying out rivers, lakes and underground aquifers.”¹³

In the past 50 years, human population has more than doubled. This rapid development with economic development and industrialization has altered the fresh water ecosystems around the world and led to massive biodiversity loss. Today, 41% of world’s population lives in river basins that are under water stress. The concern about available water resources increases with the use of unsustainable fresh water. Moreover, new citizens also have the needs for food, drink and clothing, thus putting more pressure on fresh water through the production of commodities and energy.

Table 2 - World: Population, GDP and Water Withdrawals.

Year	Population (in millions of people)	GDP (in billions of international dollars, base 1990)	Withdrawals (in billions of cubic meters)
1700	604	371	100
1820	1,042	694	237
1900	1,564	1,972	579
1950	2,526	5,336	1,382
2010	6,916	53,394	4,104

Sources: Maddison (2010), Shiklomanov (2000) and IMF staff calculations.

As a result, stresses over water are going to keep rising. As the International Monetary Fund (IMF) staff writes: “Long-term scenarios forecast large increases in water use that, for many countries cannot be met by existing supplies. With expected growth in population and economic activity, future global water use will far exceed today’s level. At the same time, freshwater availability is expected to remain more or less fixed in the coming decades. While expecting further improvements in efficiency is not unreasonable, their impact is highly uncertain. The consensus among analysts is that even substantial technological advances

¹³ World Wildlife Fund. Water Scarcity. Causes. <https://www.worldwildlife.org/threats/water-scarcity>

and investment would be insufficient to close the projected future gaps between water supply and water use.”¹⁴

Finally, this is the cause from climate change. “As humans continue to pump more carbon dioxide and other greenhouse gases into the atmosphere, patterns of weather and water will change around the world. Droughts will become more common in some places, floods in others. Glaciers and snow packs will disappear in some areas, affecting the freshwater supplies to those downstream communities. These changes will combine to make less water available for agriculture, energy generation, cities and ecosystems around the world.”

3.5. Water demand in the world

The situation of water use in the world: The demand for water is increasing, follow by the growth of industry, agriculture and the improvement of human standard of living. It is estimated that around 40% of the world’s water supply is used for industry, 50% for agriculture and 10% for living. However, the demand for water varies depending on the development of each country. For example: In the United States, about 44% of the water is used for industry, 47% is used for agriculture and 9% for living and entertainment (Chiras, 1991). In China, 7% of water is used for industry, 87% used for agriculture and 6% for living and entertainment (Chiras, 1991).¹⁵

3.5.1. Water demand in industry

The higher the growth of the industry in the world, the greater the demand for water, especially for some industries such as food processing, oil, paper, metals, chemicals and so on. Only that five industries have consumed 90% of total water used for industry. For example: It requires 1,700 liters of water to produce a barrel of 120 liters of beer. It needs 3,000 liters of water to filter a barrel of 160 liters of oil. It needs 300,000 liters of water to produce one tonne of paper or 1.5 tonnes of steel. It requires 2,000,000 liters of water to produce one tonne of synthetic resins. It is predicted that by 2000, the demand for water for industrial use will increase by 1900km³/ year which means more than 60 times of 1900. Non-refundable water due to industrial production account for 1-2% of total non-

¹⁴ International Monetary Fund (IMF). *Conversable Economist*. Timothy Taylor (2015). <http://conversableeconomist.blogspot.cz/2015/06/some-fresh-water-economics.html>

¹⁵ Environmental Science book. Daniel D.Chiras, Colorado College, 1991. ISBN: 0-7637-0860-7.

refundable water and the remaining water can be returned to rivers and lakes in the form of wastewater filled with pollutants (Cao Liem, Tran Duc Vien - 1990).¹⁶

3.5.2. Water demand in agriculture

The development of agricultural production, such as intensive cultivation and expansion of farmland, also requires increasing amount of water. According to M.I.L'vovich (1974), in the future due to intensive agricultural, the annual flow of rivers around the world could be reduced by 700km³ per year. Much of the demand for water is satisfied by rainfall in humid climates, but it usually supplemented by river or groundwater by irrigation, especially in dry season. It is estimated that the amount of water used and the quantity produced during the cultivation process as follows: to produce 1 tonne of wheat that requires 1,500 tonnes of water, 1 tonne of rice needs 4,000 tonnes of water and 1 tonne cotton needs 10,000 tonnes off water. It is forecast that water demand in agriculture will reach 3,400km³ per year by 2000, accounting 58% of total water demand in the world (Cao Liem, Tran Duc Vien – 1990).¹⁷

3.5.3. Water demand for living and entertainment

According to estimates, primitive inhabitants need only 5-10 liters of water per person per day. Nowadays, because of the development of human society, the water demand for daily life and entertainment is increasing, especially in the towns and big cities. The water has increased tens of to hundreds of times more. Following this, by the year 2000, the water demand of living and entertainment will increase nearly 20 times compared to 1900, accounting 7% of total water demand in the world (Cao Liem, Tran Duc Vien – 1990).¹⁸

3.5.4. Water stress

World Resources Institute (WRI) reveals that 37% of countries with high initial water stress experience are very high. This information is very useful for the economy, environment and communities of a country. So far, low-level water hazard data still exists. What does “water stress” means? As Safeopedia, “Water stress is a term used to describe

¹⁶ Cao Liem, Tran Duc Vien: “Sinh thai hoc nong nghiep va bao ve moi truong” book, NXB Dai hoc va Giao duc chuyen nghiep, Hanoi, 1990.

¹⁷

¹⁸ Cao Liem, Tran Duc Vien: “Sinh thai hoc nong nghiep va bao ve moi truong” book, NXB Dai hoc va Giao duc chuyen nghiep, Hanoi, 1990.

when demand for water is greater than amount of water available at a certain period in time, and also when water is of poor quality and this restrict its usage. Water stress means deterioration in both the quantity of available water and the quality of available water due to factors affecting available water.” Therefore, countries with water stress are prone to water scarcity for agricultural, industrial and domestic activities. Based on analysis of WRI, there are 36 countries facing with water stress and their baseline water stress score: Antigua and Barbuda (5.00), Bahrain (5.00), Barbados (5.00), Comoros (5.00), Cyprus (5.00), Dominica (5.00), Jamaica (5.00), Malta (5.00), Qatar (5.00), Saint Lucia (5.00), Saint Vincent and the Grenadines (5.00), San Mario (5.00), Singapore (5.00), Trinidad and Tobago (5.00), United Arab Emirates (5.00), Western Sahara (5.00), Saudi Arabia (4.99), Kuwait (4.96), Oman (4.91), Libya (4.84), Israel (4.83), Kyrgyzstan (4.82), East Timor (4.81), Iran (4.78), Yemen (4.67), Palestine (4.63), Jordan (4.59), Lebanon (4.54), Somaliland (4.38), Uzbekistan (4.32), Pakistan (4.31), Turkmenistan (4.30), Morocco (4.24), Mongolia (4.05), Kazakhstan (4.02), Afghanistan (4.01). Example: Singapore, one of the highest water stress countries, with score (5.00). A country with a high population density but no freshwater lakes or aquifers – natural supply is not enough to satisfy the demand for water. ¹⁹

3.6. The cost of water of some countries in the world

The cost of water (Second Water Utilities Data Book, Asian Development Bank): The cost of supplying water varies significantly between western and developing countries, but prices are rising all around the world. In order to provide clean drinking water, it is necessary to build and maintain a secure system for treating dirty water. These service are among the most expensive public services which is the developing countries suffering most. “In developing countries, many of those without a house connection are forced to rely on street vendors for their water and the cost can be up to 100 times more expensive than if the water was supplied to the house.

¹⁹ World Resources Institute. World’s 36 Most Water Stressed Countries. By Paul Reig, Andrew Maddocks and Francis Gassert (2013). <http://www.wri.org/blog/2013/12/world%E2%80%99s-36-most-water-stressed-countries>

Table 3 – The cost of water of developed nations

Country	Dollar per m³
Germany	\$1.91
Denmark	\$1.64
Belgium	\$1.54
Netherlands	\$1.25
France	\$1.23
UK and Northern Ireland	\$1.18
Italy	\$0.76
Finland	\$0.69
Ireland	\$0.63
Sweden	\$0.58
Spain	\$0.57
USA	\$0.51
Australia	\$0.50
South Africa	\$0.47
Canada	\$0.40

Source: Every little drop makes a difference. Asian Development Bank, 1997.

The table shows some of the variation in water prices across developed countries. The highest price is Germany, 5 times for than Canada – the lowest price. The differences in price reflect the capital and operating costs as well as cost of cleaning water. Water pricing makes a big difference. It provides a significant portion of funding for water- related infrastructure, and also creates the incentives for water conservation. However, in many countries, water is a subsidy, often based on the argument that poor people should have access to water. But in low-income countries, such subsidies are primarily beneficial to high-income people. The IMF report:

“Water subsidies, defined as the difference between actual water charges and a reference price that covers all supply costs, are inequitable. They benefit mostly upper-income groups in developing economies, as the poor often have limited or no access to piped water

and improved sanitation. Even when the poor have access to piped water, lower levels of use mean they capture a smaller share of the benefits compared with other groups. For example, Cabo Verde, India, Nepal, and Nicaragua provide the richest households with \$3 worth of subsidized water, on average, for every \$1 worth provided to the poorest households. ... Water subsidies are estimated at about US\$456 billion, or about 0.6 percent of global GDP in 2012, the latest year for which data are readily available. ... Developing Asia has the largest subsidies in absolute terms (US\$196 billion), with China accounting for more than two-thirds of that amount. Cost recovery is particularly low in South Asia despite its higher externalities from groundwater depletion. Subsidies are also substantial at the country level, reaching above 5 percent of GDP in seven countries: Azerbaijan, Honduras, Kyrgyz Republic, Mongolia, Tajikistan, Uzbekistan, and Zimbabwe.”²⁰

3.7. Solutions to protect the water by World Wildlife Fund

What the World Wildlife Fund (WWF) is doing to protect the water? There are four major measures that WWF is using to improve management of Global Water Resources. ²¹

First, Promoting water management: In order to benefit both people and nature, WWF supports and assists organizations to become responsible water manager. At the global level, WWF is working on projects to establish an international water management standard through the Alliance for Water Stewardship. WWF also supports the use of water footprinting tools with the Water Footprint Network and promotes other international initiatives with the United Nations’ Executive Director of Water and the World Economic Forum. At the local level, WWF undertakes projects to measure water use and river basin impacts and presents solutions to mitigate these impacts. WWF partners with businesses and industries to identify water risks and take advantage of opportunities to enhance water management.

Second, Protecting wetlands: The international treaty (Ramsar Convention) was established to protect the wetlands of the world. Forty years later, more than 2,000 wetlands were designated as wetlands of international importance. This means that the

²⁰ International Monetary Fund (IMF). *Conversable Economist*. Timothy Taylor (2015). <http://conversableeconomist.blogspot.cz/2015/06/some-fresh-water-economics.html>

²¹ World Wildlife Fund. *Water Scarcity*. What WWF is doing <https://www.worldwildlife.org/threats/water-scarcity>

country with wetland, is committed to protecting the area from development, pollution and drainage. About 75% of sites that added to the list since 1999 were included in the results of WWF's work.

Third, Managing Water Scarcity: When the water supply is limited and poorly managed, both the ecosystem and the people suffer. Effective and efficient water management is needed. WWF works with partners to promote the science of water conservation. WWF also works with governments, businesses and local communities to ensure that there sufficient in-stream flows for people and other freshwater species, and advance sustainable water use practices.

And the final, Adapting to climate change: WWF works to address the institutional challenges to managing water resources and protecting the living environment from the worst impacts of climate change. "This includes promoting climate change adaption in international conventions and supporting the conservation and restoration of wetlands." WWF helps assess the vulnerability of the river basin to climate change and integrates climate change considerations into river basin management.

3.8. The economics effects of scarcity

In Conservation literature (Scarcity & Growth: The Economics of Natural Resources Availability – Harold J. Barnett and Chandler Morse), the economic effects of scarcity may be differentiated in two groups: economic structure and organization of the nation and productivity, cost and price.

"Economic Structure: The Conservationists believed that--except as remedial steps were taken by government and by improved behaviour of the citizenry—monopoly would result from natural resource scarcity coupled with the high efficiency of the trust as a form of industrial organization. In turn, this would bring large unearned increments to monopolists, and maldistribution of income among the populace so severe as to be inconsistent with a democratic society. Powerful private interests would gradually gather natural resources and other wealth into relatively few hands, thus further strengthening their ability to create monopolies. Monopoly controls and pressures would be exerted—to force the sale of small landholdings, to increase and perpetuate the monopoly in other ways, to exploit consumers, to influence government activities in improper degree and even dominate political life.

From scarcity and monopoly control there would thus increasingly develop larger and larger profits –unearned increment—as the land and urban monopolies exerted their powers. The monopolistic tentacles would creep outward, to entrap and stifle all sectors of the economy. The eventual outcome would be severe maldistribution of land and property ownership, and of income.”²²

The scarcity of natural resources has a significant impact on the economy. The appearances of scarcity has created monopolies, which occupy natural resources as private property. That makes the income is not stable, the gap between rich and poor will increase. In particularly, the emergency of many monopolies is not compatible with democratic societies.

“Cost and Productivity: Conservation literature viewed scarcity as a powerful force working to reduce labour productivity and to increase the real cost of all products. The growing economy would increasingly press upon already scare resources. Destructive use of minerals would make them more scare. Encroachment of cities and highways would further reduce available resources. And waste would be the final turn of the screw to grind the American society to poverty and misery. Output per worker would decline steadily. The real cost of commodities would rise steadily. Real income per capita would fall to subsistence levels.”²³

The scarcity of natural resources leads to insufficient raw materials to create products. Products are low but the demand of consumers is high, causing an increase in cost of products. And the workers cannot produce more so their wages will be reduced, making life become more difficult. The more developed of economy, the more resources it needs to serve the needs of human. That’s why the scarcity cannot be stopped and continues to increase.

3.9. Interaction of sources of environment scarcity

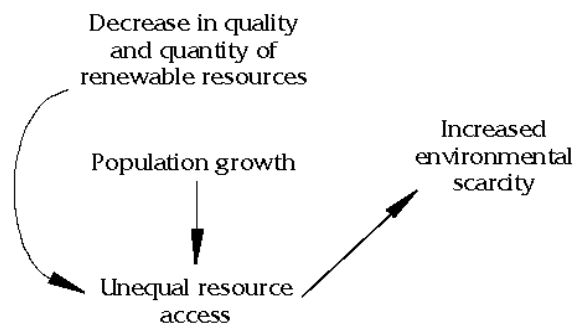
Interaction of sources of environmental scarcity by Thomas Home-Dixon (International Security - Summer 1994). Reducing the quality and quantity of renewable resources can be combined with population growth to stimulate powerful groups in society to change the

²²

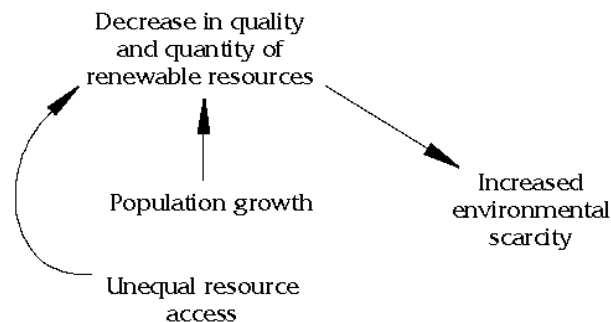
²³ Scarcity & Growth: The economics of Natural Resources Availability – Harold J. Barnett and Chandler Morse, 1963.

distribution of resources according to their support. This can cause severe environmental scarcity for the weaker and poorer groups who claim the right to use resources opposed by the forces of powerful groups. Thomas calls this type of interaction “resource capture”. Access to unequal resources can be associated with population growth to cause migration to ecological fragile areas, such as steep slopes, risk areas of desertification and “tropical rain forest”. High population density in these areas, combined with a lack of knowledge and funding to protect local resources, causes severe “environmental damage” and “chronic poverty”. This process is often referred to as “ecological marginalization”.²⁴

Scheme 2 – Resource Capture and Ecological Marginalization



Resource Capture: Resource depletion and population growth cause unequal resource access.



Ecological Marginalization: Unequal resource access and population growth cause resource degradation and depletion.

Source: *International Security* 19, No. 1 (Summer 1994): 5 – 40 by Thomas Homer-Dixon

Natural resources are considered as factors facilitating of economic growth and development. It is a factor endowment in the production process, providing inputs for the production process. On a worldwide scale, without resources there would be no

²⁴ *International Security* 19, No. 1 (Summer 1994): 5 – 40 by Thomas Homer-Dixon

production, nor human existence. However, with economic growth, resources are just a thing that need to have not must to have. For example, Japan and Singapore are two countries with no natural resources but still achieve high, continuous and strong economic growth. Conversely, some countries have rich resources but have not yet developed as African countries, OPEC. Natural resources become the economic power when people know how to exploit and use effectively. Resources also contribute to shift in the economic structure such as: oil field, coal field. Natural resources are the basis for capital accumulation and stable development. In addition, resources are institution to expand some industrial branches as: exploitation, transformation and supplement raw materials for other branches. In order to increase income and improve living standards, people have to exploit excessive resources so that resources can be exhausted and environment can be destroyed. This creates the opposite effect from nature such as drought, floods and so on. Therefore, it is necessary to develop harmony between income generation, human development and environmental protection.

And water is also a valuable economic resources, in use, the economic value of water resources is very important. Water is a renewable resources but it is easily scarce if exploited and used inappropriately. As a result, organizations around the world are still planning to minimize the depletion of water resources. They are always interested in the management of water resources, the way people supply and demand water. Certain states and international institutions are working hard to find solutions for each region and country to reduce health risks and maintain a stable, lasting and long-term global economy. That's the reason author try to investigate the situation of water scarcity on the example of the state of Vietnam. Water has brought many successes to the Vietnamese economy, especially in agriculture and aquaculture. However, there are still many places where freshwater is not available to affect the health of the people and many rivers are nearing exhaustion.

Practical part

4.1. The situation of water resources in Vietnam

4.1.1. Water resources pollution

Like many countries in the world, Vietnam is also facing enormous challenges in terms of water pollution, especially in industrial and urban areas.

Situation of surface water pollution: At present, the water quality in the upstream areas of the main rivers is quite good. However, the water in the downstream areas is heavily polluted. Particularly pollution levels in the rivers increase in the dry season when the amount of water flowing to the rivers decreases. Water quality deteriorated, many indicators such as BOD, COD, NH₄, N and P higher than the permitted standard many times.

Surface water pollution in urban areas: The main rivers in Vietnam are already polluted. For example, the Thi Vai River, the most heavily polluted river in the Dong Nai River system, has a stretch of the river “died” with length of over 10km. Regular measurement are less than 0.5mg/l, the lowest value in the Vedan port (0.4mg/l). With such a value near zero, organisms are no longer viable.²⁵

Situation of groundwater pollution: Currently underground water sources in Vietnam are facing with some problems such as salinity intrusion, pesticide contamination and other harmful substances. The overexploitation and lack of planning has made the groundwater level lower. This phenomenon occurs in the Northern delta and Mekong delta. Overexploitation will also lead to salinity intrusion in coastal areas. Moreover, underground water is polluted by the improperly poultry disease burial.²⁶

Situation of sea water pollution: Vietnam’s sea water has been contaminated by suspended solids (the Mekong and Red River delta); nitrates, nitrites, coliforms (mainly Mekong delta); oil and zinc.

Most rivers and lakes in big cities such as Hanoi and Ho Chi Minh City, where crowded population and many large industrial zones are polluted. Most of the domestic wastewater

²⁵

²⁶ Report of the University of Agriculture-Forestry of HCM city in Vietnam, 1999.

(about 600,000m³ per day, about 250 tonnes of waste discharged into rivers in Hanoi) and industrial wastewater (about 260,000m³ but only 10% are treated) are not treated. They flow directly into ponds and lakes and then into large rivers in the Red River and Mekong delta. In addition, many factories and production bases such as slaughterhouses and even hospitals (about 7,000m³ per day, only 30% are treated) are also not equipped with wastewater treatment systems.²⁷

Many ponds and lakes in Hanoi are heavily polluted, notably the lake system in Yen So Park. This is considered the waste water container of Hanoi with over 50% of the city's wastewater. People in this area do not have enough clean water for their living activities and irrigation. Their living conditions are also seriously threatened as many areas in the park where are home to germs. Although opened in 2002, Yen So Park was not used effectively due to pollution and impurities from the lake. Therefore, the development process for the park is not changed. Many rivers in the south of Hanoi, such as To Lich and Kim Nguu, are also in such polluted condition.²⁸

4.1.2. The geography and climate of Vietnam

As Food and Agricultural Organization of the United Nations (FAO), "Viet Nam is located in the eastern part of the Indochina peninsula, bordered by China in the north, the South China Sea in the east and south, the Gulf of Thailand in the southwest, and Cambodia and Lao People's Democratic Republic in the west. The total area of the country is 331 052 km². The country is divided into 64 provinces including the capital Hanoi. Based on topographic, climatic and socio-economic conditions, these provinces are grouped into eight regions from north to south: North West, North East, Red river delta, North Central Coast, South Central Coast, Central Highland, South East and Mekong river delta".²⁹

Mountains and hills cover more than three-quarters of the territory, although over 70 percent of the country lies less than 500 m above sea level. Vietnam has a dense hydrological network. Approximately 25% of the land area is covered by the delta, most importantly the North and the South, corresponding to the Red River and Mekong rivers respectively.

²⁷

²⁸ Cao Liem, Tran Duc Vien: "Sinh thai hoc nong nghiep va bao ve moi truong" book, NXB Dai hoc va Giao duc chuyen nghiep, Hanoi, 1990.

²⁹ Report of Food and Agricultural Organization of the United Nations (FAO), 2012.

Global climate change has been continue to have significant impacts on water resources. As initially estimation, by 2070, with the air temperature increase of 2.5 - 4.5°C, the amount of river flow will also vary depending on the variation of rainfall. If the rainfall decreases 10%, the annual flow may decrease by 17-53% for the air temperature increase of 2.5°C and decrease by 26-90% for the air temperature increase of 4.5°C. The highest level of change occurs in the South Central and South East.

In addition, global warming will cause the sea level to rise by 0.3 - 1m, and therefore, many lowland areas in the Mekong Delta, the Northern Delta and the Central Coast will be submerged in sea water. If the sea level rises by 1m, the flooded areas is 40,000km², mainly in the Mekong Delta. 1700km² of wetlands are also threatened and 17 million people will suffer from the floods.

Vietnam is located in the humid tropics with average rainfall of 1,800mm – 2,000mm, but unevenly distributed, mainly in the rainy season from April to October, particularly in the Central Coast, the rainy season begins and ends less than a few months.

Mr Dang Van Tuan, General Director of Ba Ha River Hydropower Joint Stock Company said that in 2015, the company has carried out production and business tasks in unfavourable hydrological conditions, affected by El Niño phenomenon, unpredictable climate change, hydrological situation in the South Central region, hot and dry weather on a large scale and no floods as usual in years. The actual water volume in the reservoir in 2015 is very low, only about 35% - 40% compared to the average for many years, only equal to 24% compared to 2013 and 59% compared to 2014.

The uneven distribution of rain precipitation and complex fluctuations over time causes floods and droughts that causes substantial damages to crops and property affecting the national economy. In addition, there are also obstacles to water management and exploitation of the river.

Finally, depletion, water pollution and scarcity of water resources will be exacerbated by poor water management measures. It is the reason why water crisis is not only due to insufficient water supply to satisfy human needs but also due to poor water management that causes billion of people and the environment suffer the consequences.

4.2. Structure of water consumption in Vietnam and water price

It is estimated that the annual rainfall of the entire territory is about 640km^3 , resulting in the flow of rivers and lakes about 313km^3 . Taking into account the amount of water flowing into Vietnam through two major river Mekong River (550km^3) and the Red River (50km^3), the total annual rainfall received is about $1,240\text{ km}^3$ and the amount of water that rivers flow into the sea annually about 900km^3 . Compared to many countries, Vietnam has relatively abundant freshwater resources, the average water per capita reached $17,000\text{m}^3$ per person per year. Due to the fact that the economy of Vietnam has not developed, the demand for water is not high. At present, only 500m^3 per person per year is exploited. This means that only 3% of natural water is supplied. Most of them are concentrated on agricultural production (Cao Liem – Tran Duc Vien, 1990).³⁰

4.2.1. Using of Groundwater

Water stored in the ground is also an important part of water resources in Vietnam. Although underground water has been exploited for use in living such a long time, however, this comprehensive and systematic resource survey has only been conducted in the last ten years. At present, the movement of sells for underground water extraction is carried out in many places, especially in rural areas by means of craft. The use of modern vehicles has also been implemented but is limited to serving production and living in industrial centres and large residential areas only.

4.2.2. Using of mineral water and hot water

According to incomplete statistics, there are about 350 sources of mineral and hot water in Vietnam. There are group containing carbonic in South Central, South East and South Western Highlands; group containing sulphur hydro in Northwest and Central Mountain; group containing silica in middle and south of Central Vietnam, group containing iron in the North Delta; group containing bromine, iodine, and borate in sediments of Hanoi and Quang Ninh coastal areas; group containing fluorine in South of Central of Vietnam and so on. Most of the mineral water is also hot water, including warm points with the temperature from 300°C to 400°C , 70 hot spots with the temperature from 410°C to 60°C and 36 very hot spots with the temperature from 600°C to 1000°C . Most of them are

³⁰ Cao Liem, Tran Duc Vien: "Sinh thai hoc nong nghiep va bao ve moi truong" book, NXB Dai hoc va Giao duc chuyen nghiep, Hanoi, 1990.

underground, only two outdoor line to belong to warm points meet in Central and South East. From the above data show that the mineral water and hot water in Vietnam are diverse in type and rich, which have medicinal effects, refreshment and many other effects.

4.2.3. Using water in agriculture

In agriculture, water has a key role in the success of rice production in Vietnam, making Vietnam as a leading exporter of rice. Currently, the water use for agricultural production most in two deltas, the Mekong Delta and the Red River Delta, accounting for 70% of water use. Water also has a decisive role in the growth of industrial crops, such as tea, coffee, pepper, sugarcane and rubber.

Water used for agriculture has increased due to the expansion of cultivated land and the intensification of crops. According to the estimation of experts, from 1990 to 2000, Vietnam has put the area of irrigation for agriculture to 6.5 million hectares with the total water needed about 60km³ and for breeding about 10-15km³.

Small irrigation systems have been used in Vietnam. The development of modern irrigation stagnated until the reunification of the country in 1975.

As FAO, in early 1975, growth was in small and medium irrigation systems, while the 1985-1990 period focused on large irrigation and multipurpose schemes. The total area of irrigation was expanded at 2.9% per year between 1980 and 1987, while between 1988 and 1994 was 4.58% per year. In 1994, there were about 3 million hectares of agricultural land in Vietnam. In 2005, the total area allocated for irrigation accounted for 4,585,500 hectares or 48.8% of the potential. The actual area to be irrigated is 100% of the area that is equipped for irrigation.

Table 4 – Irrigated crops in full control irrigation schemes

Harvested crops (2005)	(ha)
Total harvested irrigated cropped area	8,728,192
Annual crops: total	7,743,297
- Rice	6,842,127
- Maize	265,540
- Sweet potatoes	99,532
- Cassava	167,920

- Groundnuts	139,304
- Soya beans	97,119
- Sugarcane	105,800
- Cotton	14,790
- Tobacco	8,600
- Other annual crops	2,565
Permanent crops: total	984,895
- Bananas	54,626
- Citrus	46,068
- Coffee	259,607
- Tea	62,551
- Rubber	253,690
- Coconut	25,041
- Other permanent crops	283,312
Irrigated cropping intensity (on full control area actually irrigated)	190%

Source: Le Van Duong, Le Van Chinh and Ngo Tri Quang. 2006. Statistical data on irrigated crops in Vietnam. Department of Water Resources, MARD

“There are warnings that food production is likely to be seriously constrained by freshwater shortages in the next century. It is noted that the need for irrigation water is likely to be greater than currently anticipated, and the available supply of it less than anticipated” (Smith and Gross, 1999). However, the amount of water used for irrigation is becoming scarce by reducing resources, decreasing water quality and increasing competitiveness among many users and environmental factors in some Asian countries, including Vietnam.

4.2.4. Using water in economic activities

Vietnam is a Southeast Asian country, which spends the most for irrigation. The country currently has 75 irrigation systems with 659 large and medium dams, over 3,500 small dams, 1,000 drainage culverts, over 2,000 pumping stations and over 10,000 pumps of all kinds capable of supplying 60-70 billion m³ / year. However, the irrigation system has seriously degraded, meeting only 50-60% of the design capacity.

Due to the heavy rainfall and steep terrain, Vietnam is one of 14 countries with large hydropower potential. Hydropower plants currently produce about 11 billion kWh, accounting for 72 to 75% of the country's electricity output. With the length of the rivers and canals about 40000 km, has taken and exploited transport of 1500 km, which manages over 800km. According to the Ministry of Natural Resources and Environment in Vietnam, in 2010, hydropower contributed about 40% of the country's total electricity output. It is estimated that the total capacity of hydroelectricity will reach 33,310MW by 2025, of which over 80% will come from hydropower plants built on Vietnam's rivers. Besides of that, there are many rivers, streams and waterfalls used as tourist attractions.

On aquaculture, our country has 1 million hectares of freshwater surface, 400,000 hectares of brackish water surface and 1470,000 hectares of river water surface with over 14 million hectares of internal water surface and territorial waters. However, up to now, 12.5% of brackish water, saltwater and 31% of fresh water surface have been used.

Many smaller lakes and dams across the country serve for irrigation such as Cam Son (Bac Giang province), Ben En and Cua Dat (Thanh Hoa province), Do Luong (Nghe An province) ... According to statistics, Vietnam is more 3,500 small reservoirs and about 650 medium and large reservoirs for hydropower generation, flood control, irrigation, and aquaculture (FAO, 1999).

4.2.5. Using water in daily life

The daily life of people uses a lot of freshwater. Physiologically, each person needs 1-2 liters of freshwater for drinking per day. And on average, the demand for freshwater in daily life for each person is 10-15 liters for personal hygiene, 20-200 liters for baths, 20-50 liters for cooking, 40-80 liters for washing clothes by machine and so on.

4.2.5.1. In urban areas

Vietnam has 708 municipalities, including 5 cities under the central government, 86 cities and towns of province, 617 townships with 21.59 million people (26.3% of the total population). There are over 240 urban waterworks with a total design capacity of 3.42 million m³ per day. 92 waterworks of them use surface water with total capacity of 1.95 million m³ per day and 148 waterworks use underground water with total capacity of 1.47 million m³ per day.

In Hanoi, the total amount of underground water exploited is 1 100 000 m³ per day. In the southern part of the Red River, it is exploited with a capacity of 700,000 m³ per day.

Some cities and provinces exploit 100% underground water for living activities such as Hanoi, Hung Yen and Vinh Phuc. Besides of that, some cities and provinces such as Hai Phong, Ha Nam, Nam Dinh, Gia Lai and Thai Binh exploit 100% surface water. Many cities and provinces use both sources of water.

The total capacity of the waterworks can provide about 150 liters of fresh water per day. However, due to the backdated infrastructure, the rate of water loss is quite high (40% in some places). In fact, many urban centres only have about 40-50 liters per person per day.

4.2.5.2. In rural areas

For rural areas, about 36.7 million people are supplied with fresh water (in the total population of around 90 million). The ratio of population with the largest water supply is the South delta about 66.7%, the Red River delta 65.1% and the Mekong delta 62.1%.

There are more than 100,000 wells - type UNICEF of households in Hanoi, more than 200 wells of Clean Water Management Company and 500 wells of rural water distribution station.

Southern coastal provinces such as Kien Giang, Tra Vinh, Ben Tre, Long An due to fresh water sources in the rivers and canals are not enough to satisfy the needs of life. Therefore, water supply is mainly exploited from underground sources. About 80% of the population in 4 provinces of Tra Vinh, Soc Trang, Bac Lieu and Ca Mau are using underground water every day.

4.2.6. Water use in database

As To Trung Nghia, Strategy on Water Resources Development, the author have data for water use of Vietnam in 2005. The total annual water withdrawal for agriculture, industries and municipal purposes was an estimated 82.03 km³. Irrigated agriculture uses the most water, accounting for 77.75 km³ or 94.8 percent of total water withdrawals. Industrial and municipal sectors account for 3.07 km³ (3.7%) and 1.21 km³ (1.5 %) respectively. In 1990, total annual water withdrawal was around 54.3 km³, of which agriculture accounted for 86%, industrial use for 10% and municipal use for 4%.

(Table 5, figure 2)

Table 5 – Water use in 2005

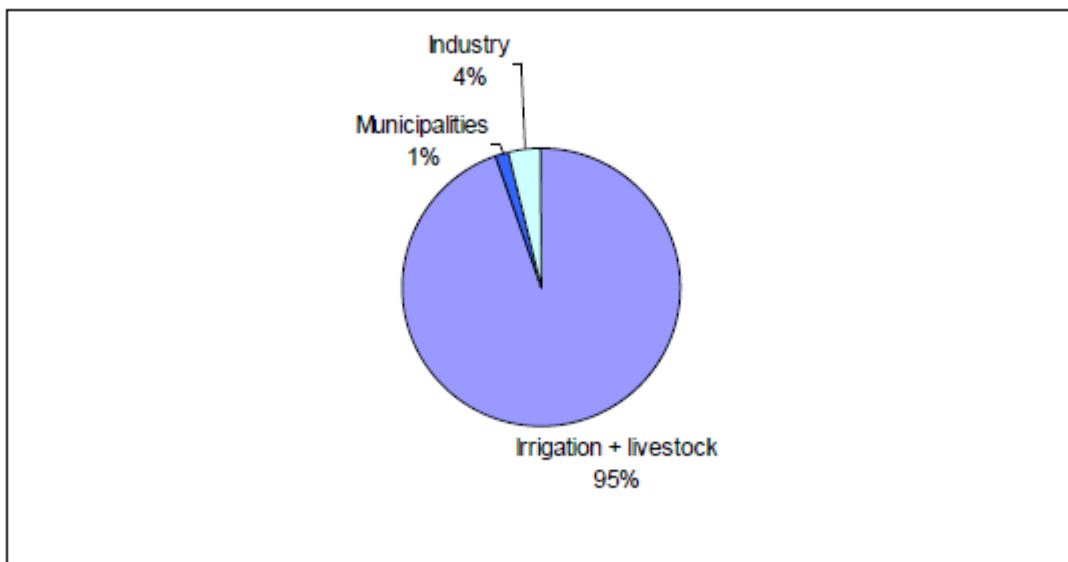
Water use

Water withdrawal:			
Total water withdrawal	2005	82 031	million m ³ /yr
- agriculture	2005	77 751	million m ³ /yr
- municipalities	2005	1 206	million m ³ /yr
- industry	2005	3 074	million m ³ /yr
• per inhabitant	2005	986	m ³ /yr
Surface water and groundwater withdrawal	2005	82 031	million m ³ /yr
• as % of total actual renewable water resources	2005	9.3	%
Non-conventional sources of water:			
Produced wastewater	2003	1 100	million m ³ /yr
Treated wastewater	2003	250	million m ³ /yr
Reused treated wastewater	2003	175	million m ³ /yr
Desalinated water produced		-	million m ³ /yr
Reused agricultural drainage water		-	million m ³ /yr

Source: To Trung Nghia. 2005. Strategy on Water Resources Development.

Figure 2 – Water withdrawal by sector

Total 82.031 km³ in 2005

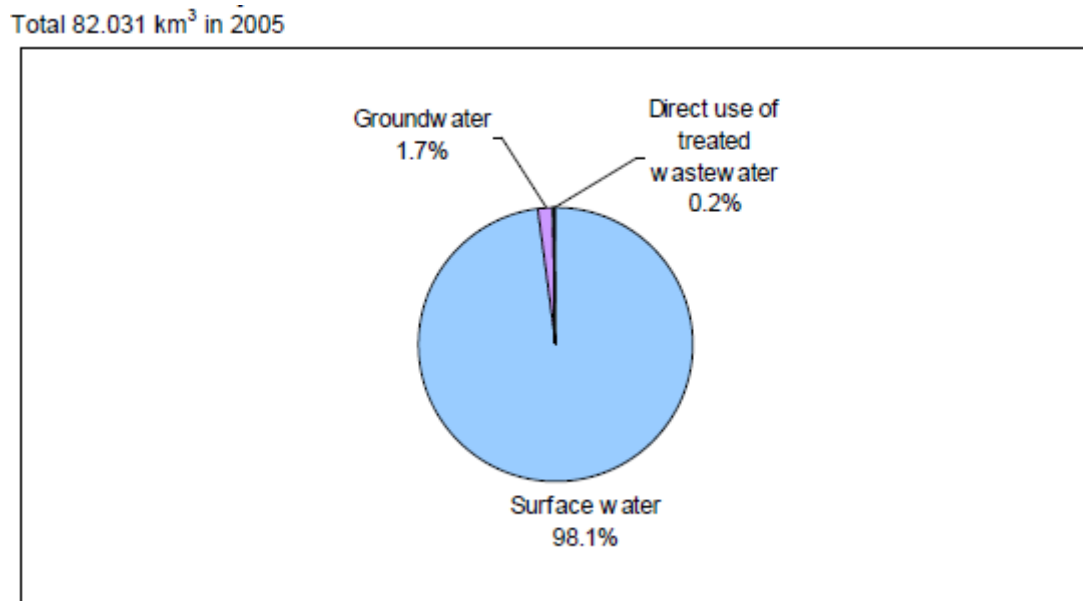


Source: To Trung Nghia. 2005. Strategy on Water Resources Development.

“In 2005, primary surface water withdrawal was around 80.45 km³ (98.1% of total water withdrawal), while primary groundwater withdrawal accounted for only 1.40 km³ (1.7

percent) (Figure 3). Groundwater is mainly used for municipal water supply in urban areas. In 2003, reused treated wastewater was about 175 million m³, which represents 0.2% of total water withdrawal. In 1990, it was estimated that less than 1.5% of the water withdrawal was met by groundwater.” (FAO)

Figure 3 – Water withdrawal by source



Source: To Trung Nghia. 2005. Strategy on Water Resources Development.

4.2.7 Water price

Each city and province in Vietnam has different water prices. Therefore, the author chooses the water prices in Hanoi – the capital of Vietnam as a typical example to get a general overview of water prices in Vietnam. The price of water is increasing according to the principle that the more you use, the more money you have to pay.

As you know, the water tariff is not fixed, it changes periodically and the water price in Hanoi has been adjusted to increase from 1/10/2015. According to the clean water price, each household using water about 10m³ per month have to pay 50.200 VND per month. But from 10/2015 onwards, a household using water about 10m³ per month have to pay 59,730 VND per month that means they pay an additional 9,530 VND per month.

Following to calculation, if you use about 15m³ per month, you have to pay about 79,850 VND per month, while the new price from 1st October you need to pay 94,990 VND per

month. Accordingly, with 15m³ per month in new price, users need to pay more 15,140 VND per month. The sale price of clean water for offices, production bases and operations has also been adjusted up to 19% compared with the old price.

Mr Le Hong Quan, manager for water supply and drainage layer, Hanoi Department of Construction, said that the increase in clean water price has been implemented in accordance with the roadmap approved by the city in 2013. “In September 2013, on the basis of the proposal of interdisciplinary, Hanoi has issued a decision on adjusting the sale price of clean water, which determines the roadmap on October 1, 2015 will increase the price of clean water. Thus, the adjustment of the price of fresh water this period is prepared with schedule and both the business units of clean water and clean water users are prepared, not sudden.”

1 USD = 22,780.76 VND (vn.exchange-rates.org)

Table 6 – Water price for household

	Household water usage level (m ³ /month/household)	Water price in 2013 (VND)	Water price in 2015 (VND)
1	The first 10m ³	5.020	5.973
2	From 10m ³ to 20m ³	5.930	7.052
3	From 20m ³ to 30m ³	7.313	8.669
4	From over 30m ³	13.377	15.929

Source: People’s committee of Hanoi City.

Table 7 – Water price for offices, production bases and operations

	User object	Water price in 2013 (VND)	Water price in 2015 (VND)
1	Administrative office	8.381	9.955
2	Unit of public service	8.381	9.955
3	Production base	9.796	11.615
4	Service operation	18.342	22.068

Source: People’s committee of Hanoi City.

Results

5.1. Policies and legislation

The Government of Vietnam has prioritized water supply, sanitation and waste water treatment.

Several international donors, including North American Aerospace Defence Command (NORAD), have committed themselves to providing funding and resources for the Vietnam National Program of Rural water and Sanitation.

Vietnam's goal is to provide clean water to 100% of the population and to reduce water losses by 20% by 2020. In addition, Vietnam will improve its mechanisms and policies to punish polluting producers as well as raise waste water costs to a level that is sufficient to cover the operating costs of wastewater treatment plants.

“Viet Nam has a relatively comprehensive framework of institutions and policies for managing water, irrigation and drainage, such as Water Law (1998, effective from 1/1/1999), Ordinance No. 32/2001/PL-UBTVQH10 on the exploitation and protection of hydraulic works (2001), Decree No. 31/2005/NĐ-CP on the production and supply of public services, Circular No. 90/2004/ TTLT/BTC-BNN on guidelines on financial management of the State Enterprises in the exploitation of hydraulic works, and Decree No. 43/2003/NĐ-CP on the specific regulation of enforcing some articles of the Ordinance No. 32/2001/PL-UBTVQH10.”

The Water Law is an important step in the management of integrated water. At present, only partial progress is made in implementing the reforms that it represents. The secondary legislation required to achieve many of the objectives of the law has not yet been developed. The law was basically built as a flexible legal framework and a number of subsequent decrees were added. These decrees define the roles, functions and responsibilities of institutional bodies for the implementation of water laws. The legal framework is described in guiding circulars, procedures for issuing permits for exploitation and use of surface water and granting permits for discharge of wastewater into water sources.

The ‘Socio-Economic Development Strategy for 2001-2010’ proposed a number of water-related strategies or objectives. With the approval in 2005 of a “National Water Resources Development” to 2020, the water sector has a comprehensive strategy and overall plan of action at the “national and regional basin level”. In addition, there are strategies and action plans for a number of sub-sectors:

- Strategy for Rural Agriculture Development in the Industrialization and Modernization Period to 2010 (MARD, July 2000);
- Agriculture and Rural Development Plan (2001- 2005) (MARD, August 2000);
- National Strategy for Rural Water Supply and Sanitation (NRWSS);
- Second National Strategy and Action Plan for Disaster Mitigation and Management in Viet Nam from 2001 to 2020 (MARD and Central Committee for Flood and Storm Control, December 2001).

5.2. Reduction of water resources in river basins

5.2.1. Severe decline of water resources in downstream river basins

Vietnam has water resources of medium class in the world, but it contains many unsustainable factors. Considering water consumption in the dry season, our country belongs to the area facing water shortage, some areas are water scarce. In recent years, water resources have never been so rare, as water demand has been increasing, and many rivers are degraded and polluted. Drought, water shortage occurs frequently, serious. Water security for sustainable development and environmental protection is not guaranteed in many parts of Vietnam.

Reduction and scarcity of water resources in downstream of rivers occur frequently while the basin climate is normal or does not fluctuate significantly as in severe drought and water shortages: 1987 1988, 1997-1998. Baseline data of 5 recent years in 40 observation stations, the average rainfall in Vietnam is about 585 billion m³, approximately 592 billion m³ on average for many years) rainy season ends earlier than usual. The dry season usually lasts for months with little or no rain. Meanwhile, surface water resources in downstream areas of hydropower reservoirs, irrigation works in the main river basins of Vietnam, such as Red River, Dong Nai River (HCM city), Thu Bon River (Quang Nam province) low popularity more than average every year.

In the downstream of Da River, Thao River, Lo River and Red River, water resources in the five years (2003-2007) were lower than the annual average of 9-20%. In Hanoi, water resources were lower than annual average of 22%, sometimes 30%. During the dry season, the water source is 50-60% lower than average. In other river basins in Viet Nam, surface water is predominantly lower than the annual average of 15-40%. In particular, rivers in southern Central Vietnam such as Binh Dinh, Binh Thuan were lower than annual average of 55 - 80%.

During the dry season in the past few years, a significant decline in surface water has taken place in downstream of the reservoirs of Hoa Binh, Thac Ba and Tuyen Quang, leading to a continuous decline in the Red River. This is a completely different phenomenon since in principle, reservoirs are responsible for adding water in the dry season. This situation is quite common in most of the other river basins such as Huong, Thu Bon, Tra Khuc, Kon, Ba, Dong Nai, Se San and Srepok. These rivers, which are quite abundant, has lost its flow or dryness to unprecedented levels over the years, again and again for a long time. The Red River and Thao River have long periods of depletion, the water source is too small and the water level is too low (the lowest water level in Hanoi is continuously low, the recent year is lower than the previous year, never seen in the past 110 years).

Water scarcity due to deterioration of water sources in downstream rivers, high impact of polluted wastewater and salinity intrusion, causing the supply of water for production and production in large uncertainties. According to the survey data, the reduction of water resources has led to water shortage, drought has been occurring on not only in some river basins but also in many areas throughout the country or in the whole country.

5.2.2. Causes of water degradation in river basins

There are five major causes of water degradation in river basins in Vietnam:

First, due to the rapid increase in population.

Second, due to overexploitation of water resources and concerned resources such as land and forests, water resources are depleted. In addition, large hydropower reservoirs in operation only for power generation also drain the downstream flow.

- As recommended by UNEP, WRI ... the water exploitation threshold should be limited to 30% of the flow, but in Vietnam there are many places such as Central part, Southeast part and Central Highland exploited over 50% of the flow in dry season, especially in Ninh Thuan and Binh Thuan provinces, exploited 70-80% of the flow in dry season.
- In many places, by reclaimed forest and land, especially sloping land, watershed forests have depleted the flow. Reduced flows in dry season to 50% of some dams such as Lien Son, Dong Cam and other places compared to the original design were the consequence of overexploitation of forests and soils.

Third, due to the uncontrolled sources of waste and the lack of proper investment in solid waste and liquid waste treatment systems.

- An increase in the use of chemical fertilizers, pesticides, aquaculture, animal slaughter and agricultural product process that contaminate more surface water and groundwater.
- Water pollution in river basins is increasing but the management is not responsive in terms of organization, capacity, equipment and lack of funds to deal with, so the risk of pollution can be extended. This is destroying the rare clean water that would later be costly to recover.

Fourth, due to the impact of global climate change.

- The warming global climate will affect water resources. Many forecasts in the world and in Vietnam showed that when the air temperature increased by 1.5°C on average, the total flow could decrease by 5%. In addition, when the earth warms up, more melting ice will cause sea water to rise, saline water will penetrate deeper in the low plains, causing fresh water to flow to the sea to be pushed back. All this will degrade the water source, resulting in insufficient fresh water sources for production and living activities.

Fifth, due to management reasons.

- In the world, when assessing the causes of water resources degradation, management has a dominant role and has a great impact. In management, Vietnam still has many organizational, planning and management problems. In developed countries, thanks to good management, their water resources are not plentiful, even very poor, as Germany has only 1301 m³ per person, England:

2465 m³ per person, France: 3047 m³ per person, Japan: 3393 m³ per person. In these industrialized countries, the city is very crowded, but because of the good use of legal, organizational and economic tools, their water resources are not degraded. The place with degradation of water has been restored.

- In Vietnam, although industrialization and expansion of urban areas, water pollution and water degradation have grown rapidly, even to an alarming level, as we have great problems in management, organization, planning and policies.

5.2.3. Solutions to reduce water loss in river basins

In Vietnam, in April 2006, the Prime Minister approved the National Strategy on Water Resources, in which the task of protecting water resources was first, followed by the task of exploitation and use of water resources, which represents the importance of protecting water resources to minimize degradation.

For the protection and sustainable development of water resources, mitigation of water resources degradation in river basins, in the Water Resources Strategy of countries, they attach great importance of construction measures and non-construction measures (management measures).

1. Construction measures.
 - To build upstream reservoirs to regulate and operate water sources, according to rational processes and concurrently build works for exploitation of surface and underground water in medium and downstream river basins in order to meet for water use and environmental flow control. Under necessary and permissible conditions, construction of water basin transformations will be required to address water scarcity areas that cannot be met by water resources in the basin.
 - In Vietnam, the total capacity of reservoirs built up to now has reached nearly 30 billion m³, accounting for 9% of total domestic flow, this amount of regulation is more effective when using the total well suited.
2. Development of waste collection and treatment systems.
3. Promote forest plantation, increase forest cover and rational use of land resources to regulate water sources, reduce floods and increase flows in dry season.
4. Management measures.

- About planning: Currently specialized planning on irrigation, hydropower, water supply and drainage has been implemented by the Ministry of Agriculture and Rural Development, Ministry of Industry, Ministry of Construction and other relevant ministries. For integrated river basin management, the formal planning of key river basins, including development planning and protection planning, should be completed and approved in order to harmonize the benefits between the upstream and downstream and between water uses for the purpose of economical, effective and sustainable.
- About documents and policies: Regarding taxation of water resources in Vietnam, it is necessary to re-evaluate tax rates and tax collection situation so as not to miss out on the many objects that can and should be collected. And, what are the sources of pollution charges, water tariffs to be used? In many countries around the world, funds collected from pollution fees and water tariffs have been introduced by the Government for water management in the river basin to provide funding for active participation measures to prevent pollution in river basins.
- About the thrifty use of water resources: For some river basins facing water constraints: It is necessary to develop a water use target for all agricultural, industrial, urban and service users to be more effective.

5.3. Solutions to protect water resources

5.3.1. Take care of water resources

Long-term strategy is providing living activities water resource safely and improving hygiene system. Short-term strategy is using some simple methods water treatment such as purifying water, boiling. Besides that, broadcast campaign to raise awareness, makes society has consciousness to protect water resource, especially need to apply strict rule to controlling pollution, force all businesses satisfy minimum sewage water standard in manufacture, avoiding environment pollution.

Method for agriculture:

- Schedule of agricultural production for each sub-region should be considered by suitability of soil conditions, habit cultivation, water supply, population growth in the coming years.

- Low-lying lands, heavy alum need to be built ecological lakes: develop aquatic product, use water for irrigation in draught period and living activities.
- Design and planning of sectors such as agriculture, irrigation, communication, aquatic product, construction should be considered synchronously to develop a complete and correct, long lasting, non-overlapping plan to avoid wasting and affecting t environment.
- Cultivate on alum soil should be followed technical guidelines to limit the stigma and remove the toxins from the soil to the surface water through alum washing process.
- Recommended farmers using microbial fertilizers, insecticides and short-duration herbicides.

5.3.2. Manage and educate community method

- There should be comprehensive cooperation between the project management board and the local committees discussing about the problem of implementation and the progress of the execution, construction method and supervision of construction works.
- Supervise the implementation of construction items according to the design, when there are environmental problems, it is necessary to propose specific solutions immediately to overcome without waiting for extended time.
- Inform people in the project area about plans and project building progress and also benefits of these projects for the people life.
- Propagate people to anti water pollution: do not dispose of domestic wastes, animal wastes and solid wastes into canals and rivers.
- Move out people living near canals to prevent discharging into canals and waterway accidents.
- A regular water quality assessment and collecting plan should be built in the area. Analysing the evolution of aquatic species composition.

5.3.3. Other methods

- Strengthen the coordination of management from departments and localities
- Strengthen patrolling to detect and handle violations

- Strengthen expenditure sources and develop a separate mechanism for salvage grass, rubbish, water hyacinth, dredge canal
- Speed up the project of wastewater and waste treatment as planned
- Improve awareness on environmental protection
- Rivers and canals system has an important role in people life. It helps drainage, irrigating for agriculture, supplying for living and industry, as well as navigation services. If management of canals does well, not to occur encroaching circumstance, waste disposal, always maintain dredging and ensure the flow then the flood problem and pollution in the city will basically be solved.
- Environmental protection is part of the overall development planning marine economy to minimize negative impacts on the marine environment and increase efficiency marine economics.
- Preventing and limiting waste from the mainland and from the above activities sea; to take initiative in coordinating and responding to marine environmental incidents.
- Protecting marine environment must be based on the protection function and using natural resources.
- Protecting marine environmental must be linked to management of natural resources and marine environment for sustainable development.

Conclusion

One of three people in the world is affected by water shortage. Therefore, there is a need for dramatic changes in water management as water is increasingly scarce and the world population is expected to increase by 2-3 billion by 2050. Vietnam is also in that risk. As the country is in the process of accelerating industrialization and modernization, the demand for water for economic development and serving people is increasing resulting in pollution, degradation and depletion of water resources.

The consequence of deterioration of water resources is very serious for human beings, the protection of the environment and river life; increasing the risk of unsustainable growth in economic development, social and environmental protection. The risk of water shortage and water scarcity is growing in the dry months. Agricultural production in many areas is stagnant and severely damaged. Some areas lack water to produce rice, forcing farmers to change crops. Providing enough water for life and production is a serious concern in many areas. Ensuring water security for sustainable development in some important areas of Vietnam such as the Northern Delta and the South is becoming a national issue.

This phenomenon is common in developing and low development countries around the world. According to a World Bank report in 1992, polluted water caused diarrhoea, killing 3 million people and 900 million people by this disease each year. In some years, the number of people suffering from roundworm has reached 900 million and schistosomiasis is 600 million people. In order to limit the negative impact of surface water pollution, it is necessary to study the waste water treatment methods, improve the sanitation of the living environment of the people, favourable organize the medical activities and public services.

Degradation, depletion of water resources, scarcity and water shortages are causing many complex problems. This is in essence a matter of equity and legal rights in water use, social issues. In principle, behaviour with water and the community should be considered satisfactorily. Social and environmental impacts are often very deep and difficult to assess and overcome.

Water - an invaluable resource that nature offers to humans, is not an endless resource, so water savings are always necessary even in places where water is abundant. Everybody needs to be aware of and take action to save water, even if it is a small act, but it will contribute greatly to protecting this precious natural resource and avoid major harm to the environment as well as our life for a long time.

List of reference.

- Barnett, H. Morse, C. : Scarcity and Growth: The economics and natural Resources Scarcity. Baltimore, Johns Hopkins Press, 1963.
- Cao Liem, Tran Duc Vien : Sinh thái học nông nghiệp và bảo vệ môi trường , NXB Đại học và giáo dục chuyên nghiệp, Hanoi 1990 (Agricultural ecology and environmental protection)
- Shelton, L.R., and Miller, L.K., 1988, Water-quality data, San Joaquin Valley, California, March 1985 to March 1987: U.S. Geological Survey Open-File Report 88-479, 210p.
- Recent Studies in Bioclimatology. Edited by F.Sargent, II, and R. G. Stone. October, 1974, ISBN 0-933876-03-3.
- General Hydrogeology. Edited by E. V. Pinneker, Cambridge University Press, 1983, ISBN 978-0-521-15483-3.
- Danilov-Danilyan V.I., Losev K.S. Water consumption: ecological, economic, social and political aspects. - Moscow: Nauka, 2008. - 221 p.
- Climate change and Food Security in West Asia and North Africa book. Editor by Mannava V.K. Sivakumar, 2013. ISBN: 978-94-007-6750-8.
- Environmental Science book. Daniel D.Chiras, Colorado College, 1991. ISBN: 0-7637-0860-7.
- International Security 19, No. 1 (Summer 1994): 5 – 40 by Thomas Homer-Dixon.
- Nestle Waters – The Healthy Hydrating Company: main functions of water in the human body. <https://www.nestle-waters.com/healthy-hydration/water-fonctions-in-human-body>
- World Wildlife Fund – Water Scarcity: Overview. <https://www.worldwildlife.org/threats/water-scarcity>
- UNICEF: The United Nations Children’s Emergency Fund. Common water and sanitation-related diseases. https://www.unicef.org/wash/index_wes_related.html

- The Mississippi River and the Gulf of Mexico dead zone.
<https://worldoceanreview.com/en/wor-1/pollution/over-fertilization/the-mississippi-river-and-the-gulf-of-mexico-dead-zone/>
- Water pollution in China.
<http://factsanddetails.com/china/cat10/sub66/item391.html>
- World Resources Institute. World's 36 Most Water Stressed Countries. By Paul Reig, Andrew Maddocks and Francis Gassert (2013).
<http://www.wri.org/blog/2013/12/world%E2%80%99s-36-most-water-stressed-countries>
- International Monetary Fund (IMF). Conversable Economist. Timothy Taylor (2015). <http://conversableeconomist.blogspot.cz/2015/06/some-fresh-water-economics.html>
- World Resources Institutes. Water: Mapping, measuring, and mitigating global water challenges. <http://www.wri.org/our-work/topics/water>
- Cost of water in Hanoi City <http://donghonuoc.org/don-gia-nuoc-sinh-hoat-tren-dia-ban-thanh-pho-ha-noi-nam-2016/>
- The Geography of Vietnam, water resources. Food and Agricultural Organization of the United Nations.
http://www.fao.org/nr/water/aquastat/countries_regions/VNM/