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Regional Development in the East Nile River Basin

- Exploring the concept of Virtual Water Trade

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Summary

Many developing countries face resource shortages in the form of water and food due to population growth. This will increase pressure on land and water to an even greater extent than today unless new ways of managing resources are found and regional development ensured. Challenges are especially difficult in Africa. The growing demand of water resources has been a source of political tension for Nile River states Ethiopia, Sudan and Egypt. Recently new ways of dealing with this tension has come about in the Nile Basin Initiative (NBI), a cooperation platform with a shared vision of managing the Nile resources in a sustainable and equitable way benefiting development in the region.

Regional development is dependent on several attributes. New directions in water science suggest that natural and social needs have to be considered to reach water security. Neo-classical trade theorists suggest that facilitating trade - based on comparative advantages - is the most efficient way of generating economic growth and hence development. In political science the new regionalism approach highlights the need for cooperation within regions for development. Regionalism is seen as a steppingstone to global influence.

The concept of 'virtual water trade' combines in a model several of these attributes. Relying on the comparative advantages of the countries, water embedded in products traded in the basin assures allocation efficiency. Since developing countries are largely agrarian economies the water is used for agricultural purposes and to a lesser extent to generate electricity. In practice virtual water trade is equalised to food trade.

One of the suggestions of further study has been to clarify the virtual water trade concept and its implications on several spheres of human and non-human activity. Therefore, the aim of this study is to explore what qualities the concept of virtual water trade has besides that of a trade model. It's implications for regional development and quality as an indicator of interdisciplinary science is explored.

More specifically the objectives of this paper are two. First objective is to explore the interdisciplinary traits of the concept of virtual water trade. The second objective is to examine the applicability of virtual water trade as a contributor to regional development in the study area – East Nile river basin.

The study highlights the importance of interdisciplinary science in sustainability studies. Taking off within the ecological, economic and social dimensions of sustainable development, theories of development are proposed to be further synergised. However, virtual water trade is one example of a concept that could be developed in an interdiciplinary direction but needs further exploration to be useful in policy discussions.

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1. Introduction

Serious challenges are facing sustainable development across the globe. However, most severe are threats to developing countries facing rapid population growth and resource depletion. The African continent is one of the most vulnerable in the world in this respect. Countries are poised with several challenges of which many are related to the availability and quality of water. For example are both water and food scarcities serious threats to peoples' well being and presents great threat to future development. The food production is directly dependent on water as a means of production consequently the management of water and land resources are extremely important to achieve food security and other development goals.

There are many examples of water resource management. In recent year the water community has advocated an integrated approach to management. The Integrated Water Resources Management (IWRM) approach is a holistic approach aimed to achieve sustainable development. An integrated approach is considering the struggle for economic and social development as related to water, that water issues cannot be treated separately from other developmental issues since it is the core of so many developmental goals. IWRM is a process, which deals with water issues in a cost-effective and sustainable way.

There are several strategies for increasing water supply, few of them are cost effective or uphold to the standards of sustainability. One strategy explored in this study is the trade of 'virtual water'. Tony Allan first explained the concept of 'virtual water' in 1998 as the water that is used in the production and production process of a commodity (i.e. food or hydroelectricity). Countries import commodities that are water intensive in production from relatively water abundant countries – thus importing not only the commodities but also the water needed to produce them. It is the water embedded in the product that is traded, not real water – hence the term 'virtual water'. (Bouwer 2000 p.227) Even though the concept of virtual water trade is rather new - the phenomenon itself is not. It is as old as exchange in food. With virtual water trade, optimisation of the use of water as a scarce input commodity in terms of environmental, social and economic value becomes possible. Virtual water trade between nations and even continents could be used as an instrument to improve global water use efficiency. (WWC 2004 p.3)

Examples of water poor countries are found in Africa along the world's longest river – the Nile. Three large countries – Egypt, Sudan and Ethiopia, make up the East Nile basin area. They all share a common water resource in the Nile River. All countries are agrarian and depend on the water for irrigation – Egypt in particular. But since Egypt is a downstream riparian it does not control what takes place upstream - in the highlands of Ethiopia for example - the main source of the Nile. The region has for this reason been prone for conflict over the declining resource. Food insecurity coupled to rapidly rising population growth especially in Ethiopia and Sudan has intensified the problems. But new efforts are mobilised in a shared vision of the basin. The Nile Basin Initiative (NBI), which includes all ten Nile States and these three in particular, is one of these efforts. It includes discussion of IWRM and virtual water as part of its subsidiary programs and is an interesting example of regional development in this context.

Including virtual water trade as a policy option requires thorough understanding of the impact and interactions of virtual water trade on the local, social, economic, environmental, and cultural situation. This is not easily done and more research on implications of using virtual water trade as a strategic instrument in water policy is needed. The concept itself needs to be

further clarified as well as to understand the links to food security and economic development in water poor countries. (WWC 2003 p. 21)

1.1 Aim and Objectives of the Study

One of the suggestions of further study has been to clarify the virtual water trade concept and its implications on several spheres of human and non-human activity. Therefore, the aim of this study is to explore what qualities the concept of virtual water trade has besides that of a trade model. It's implications for regional development and quality as an indicator of interdisciplinary science is explored.

More specifically the objectives of this paper are two. First objective is to explore the interdisciplinary traits of the concept of virtual water trade. Consequently I review literature that is based in several disciplines to collect characteristics strengthening the thesis that virtual water trade can contribute to regional development. The second objective is to examine the applicability of virtual water trade as a contributor to regional development in the study area – East Nile river basin.

The aim is an ambitious task and does not aspire to serve a new theory on regional development - rather the study illustrates the importance and possibility of connecting known theories to shed new light on a concept that might be beneficial to sustainability science and policy options. Therefore the study is laden with necessary limitations and inherent problems of interdisciplinary research.

This study's conceptual framework is based in the paradigm represented by sustainable development. Sustainable development is a normative concept based on principles of solidarity with coming generations and limits to growth. Achievement of sustainable development requires taking consideration to three dimensions of development – the natural, economic and social dimensions. However, there is not a clear definition of sustainable development directly applicable to policy analysis but has maintained a vague definition.

Integrated Water Resources Management (IWRM) is rooted in sustainable development perspective. IWRM takes a holistic approach to water management considering social implications as well as technical. The dimensions of sustainable development are here represented by theories from different disciplines adhering to the three separate dimensions. The theories chosen come from new developments in water science, international trade theory and regionalism. They are linked to the model of virtual water trade, which is an international trade model, but also has interdisciplinary qualities. To substantiate the study a case study on the East Nile river basin is provided.

The choice of study area is motivated by the developing stage of all three nations concerned, the conflict prone political situation, the water and food scarcity of the area and the environmental, economic and social relevance of the world's longest river. Most importantly is the newly launched Nile Basin Initiative (NBI), which formulates the realisation of benefits of cooperation in the region. The initiative provides a political platform and shared vision for the future development of the Nile River. All this contributes to making the East Nile river basin highly suitable for application of this evaluation of regional development.

The findings from linking the model of virtual water trade to the study area provide a critique of both the theories on which regional development was based and of the model itself. This critique highlights the need for development of Integrated Water Resources Management, which stimulates integrated sustainability research and the empirical applicability of the virtual water trade concept in regional development.

1.2 The Why and How of Interdisciplinary Research

Before moving on some clarifications are needed. A review of the benefits of interdisciplinary research is provided as well as strategy to deal with concepts.

Discipline usually refers to a subject area, such as biology, political science or physics. Knowledge generation within one discipline can benefit from knowledge from another. This is the basis for interdisciplinary. To paint a more vivid picture I borrow a metaphor from Roald Fryxell (1977) who takes a rather philosophical approach to interdisciplinary. However, he pictures it very well in this quote: *"Our formal academic categories are as arbitrary and artificial as the lines of latitude and longitude we scribe on a globe despite the continuity of the earth's surface."* He also points out that: *"If no one ever meets anyone else half way, who will ever have the background to look competently at the unexplored territory between disciplines?"* (Fryxell 1977 p. 13, 16)

The history of interdisciplinary is long. Social science and natural science were interconnected in the times of Aristotle. Charles Darwin borrowed from Robert Malthus and Adam Smith to develop the theory of evolution that produced paradigm shift across sciences. (Sandberg 2004) Following the ups and downs of trends, interdisciplinary has again become fashionable. One of the most prominent features is to use experiences and methods of other disciplines than the 'home discipline' to gain in the understanding that comes from seeing things from a different perspective. However, interdisciplinary is not a specific method - merely an approach to problem solving. How far to take the integration is dependent on the field of study and specific research topic. (Sunnemark & Åberg 2004)

The core problems with interdisciplinary research are to determine what concepts to borrow and transact with other disciplines. It is also important to recognise that some social sciences approaches relate to problems at different levels of analysis and with different focus and concepts. (Sherif & Sherif 1969) They may even belong to different paradigms. Paradigms may be described as cognitive links, the assumptions of the world that are implicitly a part of the researchers. (Bärmark & Wallén 1979) Thomas Kuhn developed the paradigm concept in 1962. He claimed that science is not a linear process or cumulative, but takes great leaps. When new consensus on basic assumptions are formed one can talk about a *paradigm shift.* (Sunnemark & Åberg 2004)

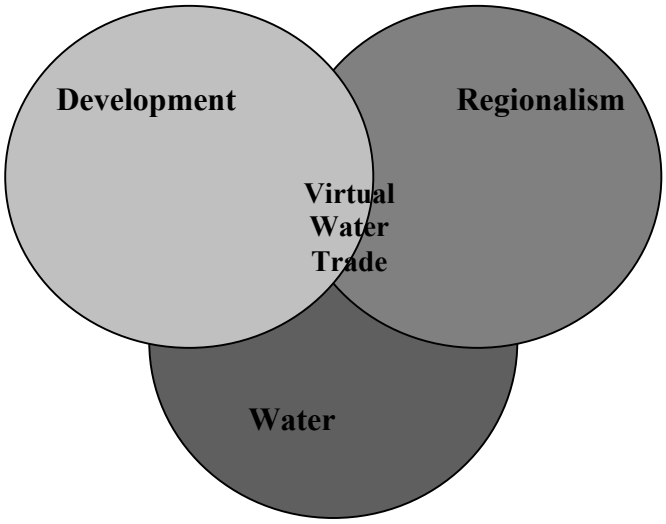
Interdisciplinary can serve as freedom from disciplinarily, producing paradigm shifts of scientific progress. However, it has to fit the problem at hand. Social sciences are beset with concepts that are constantly developed and altered. How one handles the 'concept of concept' is therefore important to the research.

Giovanni Sartori (1984) defines 'concept' as the *"basic unit of thinking"* (Sartori 1984 p. 27) Increasing a concepts properties pinpoints it within a meaningful sphere. But where do the boundaries start and end? The implication for theory is to find the proper level of

generalisation to perform the analysis. In Sartoris' words, one has to climb a *"ladder of abstraction"*. Here he uses abstraction in the meaning of generalisation. To avoid becoming too general in the analysis we are required to reduce and adapt the characteristics of a concept. (Sartori 1984 p. 45)

To find the characteristics of a concept one has to review literature. When identified the characteristics or properties of the concept may be placed in types of configurations. For example circles, partly overlapping, include clusters of characteristics. The overlapping parts represent characteristics that can be derived from one another. One of Sartori's configurations sometimes serves as an illustration for the concept of 'sustainable development'. (Sartori 1984 p. 47) This figure serves as an illustration for the conceptual framework used in this study. It will have to be somewhat modified to serve the purpose. We have to climb the 'ladder of abstraction'.

Figure 1.1 IWRM – Parts of the conceptual framework and role of Virtual Water Trade concept



The three circles represent the dimensions of sustainable development, which is the founding perspective of IWRM. As sustainable development, the conceptual framework of IWRM consists of several dimensions. In this case the characteristics of the Virtual Water trade concept and model are located within three main disciplines and theories. The new developments within water, development and regionalism suggest a new approach to regional development is necessary.

Approaching IWRM, coming from sustainable development perspective a normative concept, through traditional but separate disciplines, is not an easy task. The difficulty is to identify the characteristics of the concept in different disciplines. The disciplines have different approaches to development and the virtual water concept have developed or changed by its theoretical contexts. This is one of several challenges of the study.

1.3 Theoretical and Empirical Limitations

Since this study is carried out in an interdisciplinary way but directed, not only to an interdisciplinary reader, I have opted to provide short background material in which the three disciplines are rooted and then focused on the relevant part contributing to the virtual water trade application, thus accounting only for partial coverage of theories. In some instances the connection between virtual water trade and food security is regarded obvious and therefore the two concepts are almost equated. It is acknowledged that food security entails much more than just food imports and has other implications that are not considered in this particular study. Food security is thus treated almost as a positive side effect and motive for virtual water trade.

Several of the critical points in the study rely on definitions of the concepts that are used. One such concept is 'regional development'. *"Regional development can be viewed as a holistic process whereby the natural and physical environmental, economic, social and cultural resources of a region are harnessed for the betterment of people in ways that reflect the comparative advantage offered by the inherent and geographically different characteristics of the area."* (UWA website 2004) Deriving from this definition but more specifically regional development is defined in this study as: water and food security, economic growth based on international trade as according to the neo-classic economic paradigm and regional cooperation in the African context.

Regional development combines several factors originating from the different disciplines. The quality and quantity of water especially for agricultural uses are closely related and receives increasing attention from water professionals. As do the environmental services provided for by water and the impact of human activities on this water. Regional development in the sense of agricultural policy and irrigation policy must therefore be revised to reflect these recent changes in the water discipline.

The neo-classical economic paradigm, not too well supported by environmentalists, but nonetheless, the prevailing paradigm within UN development agencies such as the World Bank and IMF (International Monetary Fund), is also the paradigm on which the concept of virtual water trade relies.

Regionalism is the 'new buzzword' in international relations of today. Water management and policy are increasingly dependent on international relations since 80 % of all waters are transboundary making up- and downstream riparian states irrevocably interdependent. Hence, the water issue is regionalised to its very nature. How these potential conflicts and issues are managed is very important to the regional development. However, the vast literature on water and resource conflicts will not be reviewed in all its complexity, rather I will settle for a general discussion.

A lot of assumptions are inherent in the prevailing paradigms of the disciplines. For example do natural science water professionals tend to either disregard or not comprehend the complexities of political and economic processes as well as political and economic disciplines tend to overlook natural cycles and physical rules when formulating policies. The existence of these imperfections in theory is recognised but because of trade-off between comprehensiveness and span of the study not always elaborated upon.

The virtual water trade example is relatively new as a theoretical concept even though the practice of trading food carries a long history. Tony Allan developed the concept in 1998 carrying out case studies on the Middle East region. The concept has since been used mainly in quantifying studies but not really further developed by several academics. Dennis Wichelns is one who has tried. His study on comparative advantages of the main up- downstream countries as well as another study on the Nile countries - Ethiopia, Sudan and Egypt – helps provide this study with an empirical illustration of virtual water trade and regional development. (See Wichelns *et al.* 2003 and Wichelns 2004)

The study is based on secondary data. The relevance of the reviewed information is substantial. The selection of material has been according to some criteria. It has been beneficial if the material has had interdisciplinary traits or been aimed specifically to developing countries, i.e. Africa. However, its representatively for new tendencies have also been important particularly in the case of regionalism and water. Regarding water the main source used is provided by Malin Falkenmark, a recognised authority in the water field with decades of academic research behind her. The regionalism field has a growing amount of literature. Here time has been limited exploring the possibilities of resources. The main resources Asante and Grant and Söderbaum have been selected largely because of their explicable consideration of regionalism in the African context. Trade theory literature is vast as well. The limited selection provided here is restricted to textbook generalisations and narrowed down with Dennis Wichelns studies of virtual water trade and comparative advantages in the Nile Basin, which have provided inspiration for this study. Only short critique of neo-classical paradigm has been allowed. However, due to the 'freshness' of the other paradigms (integrated water resources management and regionalism) little critique of these has been managed.

The case study appears in the second part of the paper, which starts with an overview of the theories. The following chapter presents the conceptual framework IWRM and introduces the concepts of virtual water trade and food security. The third chapter introduces the hydrological cycle and new developments in water science. The forth chapter deals with the economic dimension and presents the neo-classical trade theory as well as critique against it. Theory of regionalism, particularly in African context is provided in chapter five. The case study of the Nile river basin is presented in the next coming chapter. The virtual water trade concept is explored in chapter seven and the last chapter concludes the study.

2. Integrated Water Resource Management (IWRM)

This chapter provides an introduction to the conceptual framework of the study. It is within this framework the analysis will be performed. It also offers an introduction to the concepts of virtual water trade and food security as well as showing the rational to link these concepts to other theories, as according to IWRM and regional development.

2.1 Developments of Water Policy

The environmental movement gained momentum in the 1960s, grew into a persuasive movement in the 1970s and was starting to contribute significantly to policy change in the 1980s. The environment had now a voice in discursive political process. The efforts resulted in construction and amendment of treaty based regimes. Most early water treaties were sectoral to their nature and governed only specific activities such as fishing or navigation. They were agreed to regulate competitive uses of freshwater resources. Few had substantial principles other than those regulating sovereign interests amongst riparian states making them inflexible to ecological concern. Not until recently have a more ecosystem oriented approach been applied in international treaties. (Toope *et al.* 2003)

The first international program dedicated to water was the UN International Water Supply and Sanitation Decade 1980-1990, which were set off by the Mar de Plata Conference on Water in 1977. (Wescoat 2003) The International Conference on Water and the Environment in Dublin 1992 followed - a preparatory meeting for the United Nations Conference on Environment and Development (UNCED) in Rio. The Dublin principles were first to recognise Integrated Water Resource Management (IWRM) in an international document. IWRM, which took stance in a holistic view on water management, was thus recognised as a concept and included as one of the principles used in Agenda 21 later that same year. (Björklund 2001)

The water issue received relatively little attention at the Rio conference where most of the focus lay with climate change and biodiversity. Despite this, the extensive preparation in Dublin contributed to make the water section of Agenda 21 the most detailed and longest one. In that chapter it is evident that the IWRM principle is recognised. There is a need to adopt *"holistic management of freshwater as a finite and vulnerable resource"…"integrated water resources management, including the integration of land and water related aspects (…) at the level of catchment basin or sub-basin."* (Agenda 21 Ch. 18 in Toope *et al.* 2003 p. 4)

The recognition has also come that developing countries are especially vulnerable to water issues, whether allocation, quality or management. At the World Summit on Sustainable Development (WSSD) in Johannesburg 2002 it was stated that countries should *"develop integrated water resource management and water efficiency plans by 2005, with support to developing countries"* (Jonch-Clausen 2004 p.6)

The 2nd World Water Forum was formed by water professionals to decide on a plan of action in 2000. (Wescoat 2003) IWRM was referred to when important issues such as securing of food supply, valuing of water and water governance were discussed. (Björklund 2001) Follow up forums have different themes, the next (4th World Water Forum scheduled to be held in Mexico 2005) has the theme of water and food security.

An exact definition of IWRM is not yet established but Global Water Partnership (GWP) offers a common definition: *"IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."* (GWP 2000 p.22) It requires recognition of the full hydrologic cycle but is not a blueprint for how to deal with water issues in a cost-effective and sustainable way.

2.2 Justifying IWRM

The issue of IWRM have gained momentum in the water science community and with water management professionals because of a number of explanations. One explanation is the increasing demand for freshwater caused by population growth, which other remedies have not been able to solve. Hence, a new paradigm, which recognises the water issues as a political process that requires transparent policy-making, inclusiveness, consultation and that fulfil legitimacy principles, is developing. (Toope *et al.* 2003)

This paradigm shift is grounded in the fear that growing world population will increase the pressure on finite water resources through increased consumption and production. Already a third of world population experience medium or high water stress and the ratio are increasing. Estimates show that in 25 years food will be required for 2-3 billion more people. Water is the main constraint on food production and irrigated agriculture it is therefore likely to increase. It already amounts to 70 % of all water withdrawals – that is more than 90 % of all consumptive water. (GWP 2000)

Meeting the basic sustainable water use is a complex challenge that requires integrated water resource management. The compromises must find a balance between land use and ecosystem services. This complexity is particularly important in developing countries. (Björklund 2001) Complementary elements of an effective water resource management system must be development and strengthened concurrently. This requires the development of an institutional framework capable of integrating human systems, economic, social and environmental policies. (GWP 2000) The complexity of the issues is stressed by changing trade policies, development, urbanisation and industrialisation that increase demand and reallocation of water resources, all of which further highlights the importance of an inter-disciplinary approach. (Björklund 2001) Water's role in socio-economics has not yet been well understood. (Falkenmark 2001)

New integrative approaches are for example the theme of security, whether environmental or political security. (Wescoat 2003) Co-operation within an international river basin may be necessary as there are substantial political tension and conflicts on regional level. Protocols should be developed on regional level, commissions and agreements on river basin level. Riparian states should cooperate on transboundary water resources, searching for negotiated agreements respecting all riparian countries' interests and based on equitable and reasonable use of water. Usually they can be part of more global agreements. (GWP 2000)

2.3 Virtual Water Trade and Food Security application

Integrated land and water resources management nationally are required to achieve rural economic growth, which is a pre-requisite for overall growth. To achieve food security a local pattern for providing food locally should be developed and economic preconditions be established to import food. Even EU development policy recognises that food security needs to be ensured by regional distribution rather than by national. If a transition from self-reliance to regional food security takes place as recommended, it might also include virtual water trade since an integrated land and water resource management calls for improved water efficiency. (Björklund 2001)

Recognition of current maldistribution of food across the world and the need to increase market access for developing countries lies near the conceptualisation of sustainable development, especially for developing countries. (Drimie & Mini 2003) Developing countries are dedicated to hydro development but since socio-economic development is urgent it is prioritised over environment in the policymaking. However, the start to technical and institutional reforms is social and political awareness of water issues. (Allan 2003)

Moreover, virtual water trade's possible contribution to policy is increasingly receiving attention. For example was virtual water trade one issue discussed at the 3rd World Water Forum held in Tokyo 2003. But as time did not allow extensive debate on the issue, an e-conference was launched to continue the debate and to enhance the understanding of different viewpoints on the potential and impacts of virtual water trade. (WWC 2003)

IWRM provide the necessary thought framework for analysis. However it does not as yet have a clear theoretical definition or use - it is rather a blueprint for policy making. Yet, it has quickly gained momentum in the policy debate despite its normative stance. For example are the new developments in water science, reviewed in the following chapter, based on this view.

3. Water

In this chapter we see that water science has developed to a multidisciplinary effort continuously evolving. The hydrological cycle will be presented and connected to the concepts of food security and virtual water. A new water paradigm, which considers 'blue' and 'green' water and the implications of 'blue' water bias, is presented.

3.1 The Hydrological cycle

Water science is an ancient science. It has been one of the prerequisites for survival. Man has always been dependent on water to drink, for cooking and to produce food - whether to water cattle, prey or crops. To know the flows of water was therefore essential to be successful in developing a society.

First to recognise is that the hydrologic cycle is dynamic both spatially and temporally much because it 'flows' though different stages of the cycle and take different forms. It flows in response to gravity, evaporation and transpiration and the competition between these forms the ecological relations of the biosphere. (Toope *et al.* 2003)

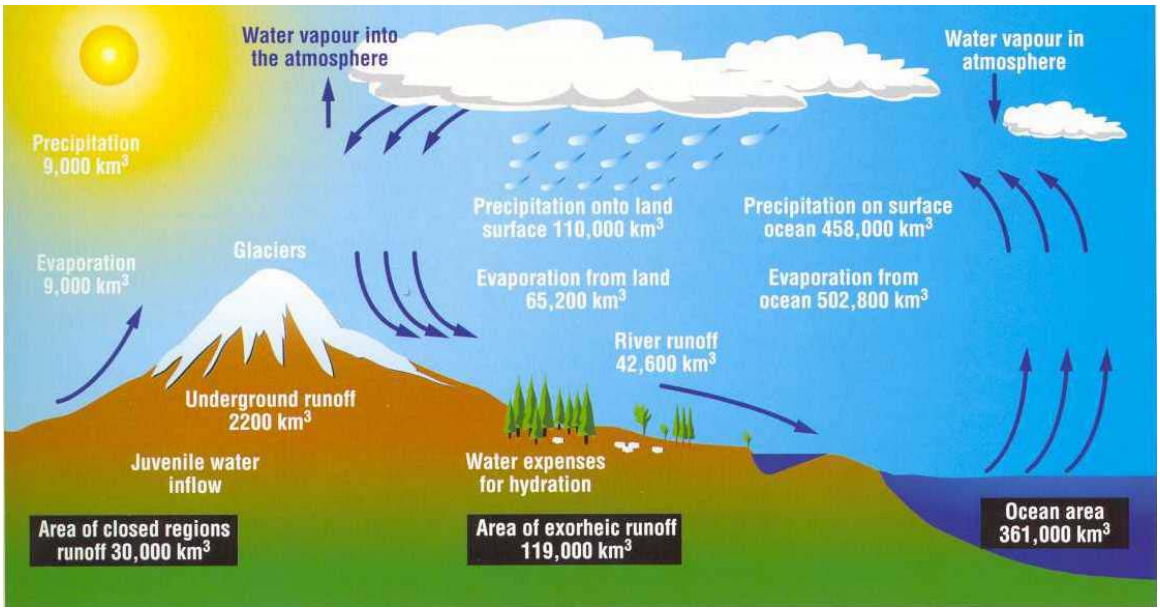
A physical rule about the hydro cycle that we recognise from the law of thermodynamics is that *"Water is not created or destroyed in this process but simply changes form and location."* (Cech 2003 p. 26) Although water on a global scale cannot be lost since the hydrological cycle is a closed system, this does not mean that this is true on a river basin level. Since water change physical state and location it is important to know where and how to access the main sources. (Wood 2003)

Water is commonly found in the Earth's environment. It appears in three different forms: liquid, solid and vapour water. The liquid water is the water we usually imagine when we think of water, oceans, rivers and streams – water in motion. It is true that water is always more or less in motion taking on different forms. The transformations are illustrated in the hydrological cycle (figure 3.1 below). However water can also be stored in groundwater and solid shapes or as component of other materials. This complicates the estimates of water volumes so the figure's amounts are just estimates. (UNESCO 2000)

Water is a renewable source consisting of different forms of water. The water flows through this cycle but the relation between forms stay roughly the same. Even though the earth sometimes is called the 'blue planet' most water consists of saline ocean and sea water (97 %). Most important for human survival is the freshwater but most of it tied up in glaciers and ice, 30 % is groundwater and less than 1 % is stored in lakes and rivers and therefore usable for human (and many ecological) purposes. (Wood 2003)

The hydrological cycle contains of the four main components - precipitation, runoff, storage and evaporation. The main functions of the hydrological cycle are driven by solar heat. Evaporation in form of water vapour from oceans and earth surface is accumulated in the atmosphere returning to the surface as precipitation. When hitting the ground some water returns directly through evaporation but some penetrates the soil contributing to groundwater recharge. However, most water is collected as runoff finding its way back to the ocean or lake in rivers and streams. (UNESCO 2000)

Figure 3.1 The Hydrological Cycle (As illustrated by UNESCO 2000)



For supply of water for human activities the river water is most important. It is the largest source of renewable water accessible to human societies and has therefore received much attention. It is concerned so valuable that it is used to estimate water availability in regions. Furthermore, river runoff does not only have importance for recharge quantitatively, water quality is also restored due to its river's function in ecological systems. (UNESCO 2000)

Two important forms of freshwater are surface water and groundwater. Both these sources of water are so-called 'blue' water. This means that the water appear as a body of water. 'Green' water is water that does not appear in lakes and rivers but rather as water vapour and soil moisture. This water is in an infiltration stage from surface runoff. Green water cannot be regarded as a body of water but is extremely important for the productivity of the land. (Wood 2003) Presently 60-70 percent of food production is rain fed if green water flow in the form of water vapour is included. Almost 90 % of water vapour flows from the continents are involved in plant production. If plants use more water, the green water fraction increases on expense of the blue, which is the recharge to rivers and aquifers. The blue water flow sustains ecosystem and human activities. The green water flow on the other hand sustains all biomass growth, thus its importance for food security. (Falkenmark & Rockström 2004)

Still, management cause larger variation in green water requirements than does hydro climate (precipitation and climate). If green water can be managed more efficiently more blue water can be secured for ecosystem services and human activities. (Falkenmark & Rockström 2004)

Approximately 110 000 km³ of precipitation falls on the continents per year of which almost half is transpired from native vegetation, 20 000 km³ is transpired from irrigated crops and surface water evaporation. Only 12 000 km³ are utilised for industrial and domestic use. Of this water 69 % is used for irrigation, 23 % for industry and 8 % for domestic supply. The estimates vary a bit from different studies. (Wood 2003)

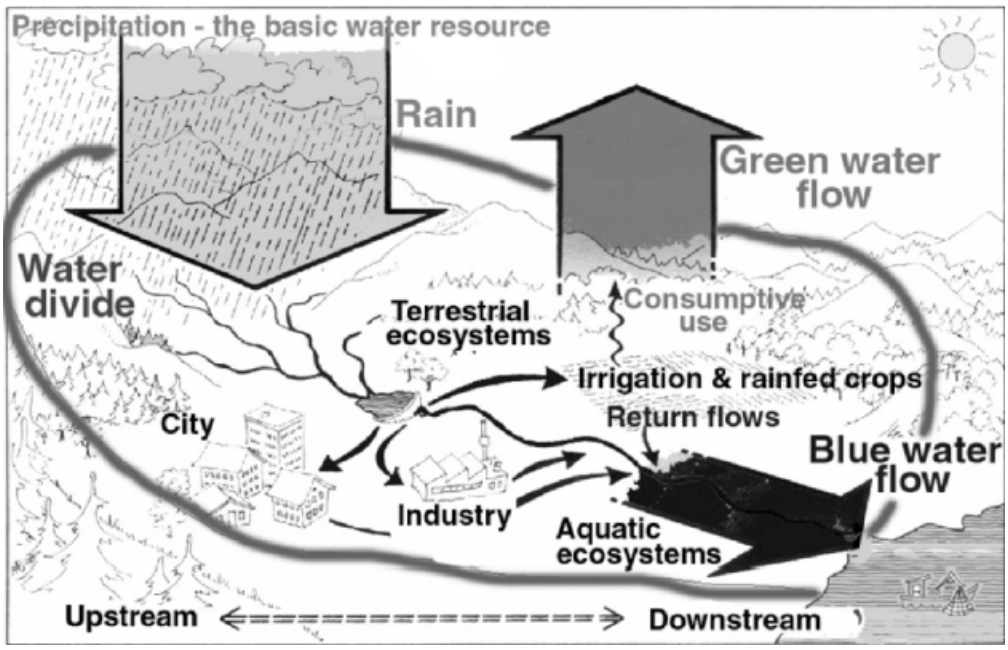
3.2 New Considerations in Water Science

Water becomes more expensive the scarcer the resource becomes, which increases the need for efficient management. Allocation of resources are not always obvious, therefore an integration of the political process is unavoidable to find legitimate solutions to the problem. An interdisciplinary body of literature has been developed to fill that void in water science. (Zilberman *et al.* 1997) This has been unwelcome by some environmental scientists and professionals since it recognises the political and normative nature of integrated water management. (Toope *et al.* 2003) Nonetheless, ingenious engineering can only stretch the limits so far. It will eventually be restrained by thermodynamics and kinetics of the system. Basin-scale and global water systems require a more holistic conceptual framework. (Wood 2003)

Arid regions are at most risk of residents' stretching supplies to unrealistic demands. This will have negative impact not only on financial systems but will generate changes to the hydrologic cycle affecting valuable ecosystems. (Toope *et al.* 2003) There is growing recognition in the water discourse of land use policies and practices effects on water resources. For example did the International Water Management Institute (IWMI) launch an International Dialogue on Water, Food and Environment in 2001, which main focus is on the changes by human water use and how it has created pressure on the agricultural water use, especially on irrigation. (Wescoat 2003)

One of the leading advocates of the integrated approach is professor Malin Falkenmark who argues that the hydrological cycle is affected by land uses. Together with Johan Rockström she suggests a new water paradigm to be developed. This paradigm expands the fresh water concept to include both blue and green water so their respective part in nature and society can be understood. Their starting point to the hydrological cycle is precipitation, not runoff. But both runoff and water vapour contribute to ecosystem services and support human societies. Falkenmark and Rockström's modifications include links to ecosystem services as well as human activities are shown in Figure 3.2 below. (Falkenmark & Rockström 2004)

Figure 3.2 Precipitation – the basic water resource



The new paradigm they propose – eco-hydrology – include both spatial and temporal approaches. Recharge rates vary depending on the form water is in and where it is located. Eco-hydrology also considers water quantity and quality together, supplying temporal knowledge. The paradigm is more concerned on water services than movements and these considerations are believed to expand the sustainability approach to water issues. (Falkenmark & Rockström 2004)

Eco-hydrology relates links between land and water use but also between upstream and downstream uses of countries in a basin. Population growth, urbanisation, industrialisation and globalisation are contributing to resource pressures. Even so, current water science is addressing only part of the problem – the visible water. The role of water in development of environmental problems and threats to ecosystems and the food production dilemma are more closely linked to waters function in the biosphere than previously acknowledged. Learning how to cope with the constraints of the system is basic challenges for new water science and policy making. (Falkenmark & Rockström 2004) Governance, increasing needs for water for food production and challenges to improve efficiency through 'more crop per drop', environmental flows to sustain ecosystem function and the effect of climate change on the hydrological cycle are all important elements to relate to. (Jonch-Clausen 2004)

3.3 Virtual Water Trade and Food Security Application

Human dependence on water resources is more complex than recognised earlier. The understanding of human pressure on water for agriculture will enable the options of the use for water for ecosystem support. Irrigation data is based on blue water use. More difficult is to quantify the green water contribution to food production. One complication for the estimates is virtual water trade. In the Middle East and North Africa most agriculture is blue water supported but also depends on virtual water imports. (Falkenmark & Rockström 2004)

Three main ways to increase crop production include increasing cultivated land, increase cropping intensity and number of harvests or to improve yields. These techniques have problematic consequences. Different land management, turning forest into fields or deserts into arable land will have great impact on fresh water sources. Increased cropping intensity will require more fresh water affecting alternative uses. To increase yields would have the least impact of the three food production strategies from a water perspective. Alternate land uses have the most impact in comparison. The authors are suggesting that evaporation is shifted to transpiration. Increased transpiration entail the productive use of water hitting the ground increases since it goes through the processes of biomass production. Estimates are that 1300 m^3/person/year is the water volume required to produce necessary food. Almost three times as much water that is presently used in irrigated agriculture will have to be used in the next 50 years provided the rate of population growth persists. (Falkenmark & Rockström 2004)

Falkenmark and Rockström argue that the mainstream recommendation of importing food to meet a growing population's food demand is not necessarily enough in a long-term perspective. Still their recommendation for regions that already experience blue water scarcity and that have limited green water resources as well, is to take part in virtual water trade as well as improving irrigated agriculture. In closed basins with no additional water supply, virtual water is the only way to increase food security. (Falkenmark & Rockström 2004)

Considering ‘blue’ water bias and the implications for food security and other human activities is important not only to the management of water resources but also to the way we think about water as a resource. The uniqueness of water and the services provided by it is of vital importance for the value we ascribe to it. The value of water depends on its uses hence attitude to water matters. We now move on to see how economists treat water and other resources and what implications that might have for virtual water trade.

4. Development

In this chapter some paradigms of development theory are presented. The neo-classical theory of trade is in focus and some critique against it is also provided. Trade theory is then used to explain the virtual water trade model.

4.1 Development Paradigms

Development economics have been the systemic way of explaining the situation of the least developed countries (LDCs). Development economists, such as Gunnar Myrdal and Raul Prebich, have argued that developing countries are so different from the already industrialised countries that neo-classic models do not apply. These countries were only suppliers of raw materials and suffered from unfair 'terms of trade', which doomed to keep them in that position, in other words they were 'too late' to develop. The neo-classical defence put the blame on the politics of the LDCs rather than the market forces. Government policies were distorting market incentives and not the other way around. (Gilpin 2001)

The debate on the relative importance of state and market has been fierce. In the 1950s to the 1970s the role of the state was emphasised in development economics. In the 1950s protectionism was considered beneficial to development, which was then equated with industrialisation. Involvement of the international community and the state should play central roles in the development of the poorest countries, emphasising import substitution and protection of domestic industry. The cost of industrialisation was suggested to be reduced by regional trading arrangements expanding the size of markets. In the 1970's and 80's the neo-classical belief on the market mechanisms' ability to drive economic growth and thus development was prevailing in both academia and policymaking. (Gilpin 2001) The criticism of trade theory became louder during the 1960s. Criticism was free trade advocates dealt it with in a way that is still common defence. The administration of theory, not the theory itself was faulty. There were and are still too many obstacles restricting trade according to free traders. (Winters 2003)

In the relation between development and environment two distinctive approaches to linkages can be identified. The division is fundamentally about whether to see human future as positive or negative. The Malthusian approach included well-known names such as Paul Ehrlich, Donella Meadows (Club of Rome) and several more that believe there are limits to growth. Robert Malthus himself argued that as population grew bigger resource scarcity (food or land to grow food) would be exhausted. What he had not included in his model were technological factors or fertility of land nor had he included in his theory the self-regulating capacity of humankind. David Ricardo included fertility of land in the model and argued that cost would increase as land grew scarcer and thus cost would have negative impact on long-term economic growth. Ehrlich contributed to model technological change and included environmental degradation as a result of population growth. This helped shift the emphasis from limits to growth to concerns of economic sustainability. (Hussen 2004)

The other approach is based in the neo-classical school of thought. The neo-classicists consider economic growth always to be possible because of forever improved efficient use and allocation of resources, regardless of if resources are finite or not. The neo-classics believe problems will be solved through either technological advances or substitution.

Economic growth and thereby increased income is supposed to solve both the population problem, as illustrated by the demographic transition, and the environmental Kuznets' curve that assume decrease of affluent at certain point of income level. The neo-classical assumption that human knowledge is the driver of economic growth is based on the historic pace of inventions. Question is whether inventions will keep the same pace as in the past. (Hussen 2004)

4.2 Neoclassical Trade Theory

Early literature on development focused on capital and economic growth on macro-level whereas the current literature concentrates on economic efficiency and productivity increases on micro-level. Still, industrialisation is in the midst of development strategy, the shift has been from accumulation and pace of industrialisation towards its efficiency. (Deepak Nayyar 2003)

Neo-classicism has been the dominant paradigm in development theory. It is based on the ideas of Adam Smith and David Ricardo - the 'founding fathers' of trade theory. The reason countries trade is that goods carry an opportunity cost i.e. the cost of a product in other products. If all countries were to produce all goods it needed it would be inefficient. Another country could produce one of the things and then the two countries could trade the goods. It allows each country to specialise in producing the good in which it has a comparative advantage entailing rearrangement of world production beneficial to all parties. Comparative advantage is the good that has the lowest opportunity cost in terms of other products in *comparison* to other countries. The determinant of the opportunity cost in the Ricardian model (early 19th century) is the productivity of labour. The model has been extended to incorporate *specific* factors of production too, such as land and capital, which allows for a model explaining income distribution effects of international trade. Another model explaining international trade is the Heckscher-Ohlin model, in which *resource differences* are the only source of trade. The countries here tend to export goods that are intensive in factors with which the country is abundant. (Krugman & Obstfeld 2003)

4.3 Critique of Neoclassical Theory

There is an array of critique against the neo-classical trade theory and the relationship between trade liberalisation and development. Recently the neo-classic resource economics is losing ground to economic paradigms that focus on political and evolutionary processes. Among these are ecological economics and sustainability economics that try to merge ecology and economy by introducing concepts such as thermodynamics and other ecological principles. One of the most forceful critics is Herman Daly that has formed an alternative growth paradigm – the steady-state economy that tries to incorporate the concepts of sustainable development. Daly's critique of the neo-classics is that they have ignored both the ultimate means and ultimate ends of economic growth since they are too preoccupied by materialistic matters. Sustainability economics critiques the neo-classical focus on efficient allocation of scarce resources and include fairness and equity of other species and future generations. (Hussen 2003)

Other criticism comes from new economic theories that argue that neo-classic paradigm is not developed for dynamic processes because it lacks both spatial and temporal dimensions. It

also largely ignores economic and other institutions' impact. The Heckscher-Ohlin model has been accepted as the standard explanation of trade as a result from comparative advantage but the main problem is that actual trading patterns differ from what the theory predicts. (Gilpin 2001)

4.4 Virtual Water Trade and Food Security Application

Dennis Wichelns (2004) explains how the economic concept of comparative advantage may be may be helpful to water resource professionals who are using the virtual water metaphor to describe strategies for enhancing the value of a nation's limited water supply. He also notes an increasing interest from water professionals for virtual water and suggests that policy will have to take it into regard but warns that policy relevance may be limited. He argues that water-short nations can enhance their welfare by importing virtual water from nations with larger water endowments. Authors using the virtual water metaphor in these contexts have enhanced the discussion of the relationship between water resources and food security. Consideration of opportunity costs must be included in policy discussions to ensure appropriate policy alternatives. (Wichelns 2004)

The underlying motivation of importing food is to fill the domestic shortfall of food supply and to maintain social stability. Many poor countries lack the necessary financial ability to either develop infrastructure for irrigated agriculture or purchase food from the international market. One nexus is the opportunity cost of water for these countries. Could the money they invest in development of infrastructure (i.e. irrigation etc.) be better invested in other sectors that contribute more to development whilst food import ensures the food security? Sectoral policies, such as agricultural taxation and input and output policy profoundly influence farmers' decisions regarding cropping and water use. Increases in virtual water trade could provide significant benefits by reducing the negative environmental consequence of distorted agricultural policies. (WWC 2004)

Water as an environmental, social and economic good provides us with new important aspects in poverty reduction strategies. (Björklund 2001) Especially in Africa water has potential to serve as something more than just a natural resource – a good. In the next chapter the links between trade and cooperation is reviewed as well as the characteristics of regionalism in Africa.

5. Regionalism

This chapter begins with a general discussion of what regionalism entails. It goes on concentrating on regionalisation in the African context and later shifting focus to economic integration especially in Africa. A discussion of water and conflict management follows as well as a section on virtual water trade and food security.

5.1 Definitions of Regionalism

Study of regionalism is a hybrid and extension of sorts between international relations theory (IR) and international political economy (IPE). These theories are by and large state-centric concentrating on interstate relations. They usually originate from realism and liberalist traditions where states are concerned the most important actor driven by its power relations. Regionalism theory place more weight on mutual dependencies as driver of states' relationship to each other. While realist theories are preoccupied with conflict between countries, regionalism examines cooperation between countries, usually within a region.

However, there is no one model for the theory of regionalism but three major theoretical tendencies. First are the systemic theories that see regionalism as a result from reassurance from external forces. The second one consider interconnectedness and interdependencies as the driving forces for regionalism, while the third one cover the domestic level and explore for instance the impact of democracy. Presumably all three models are needed to understand the driving forces of regionalism. (Smith 1997) Here the focus lies mainly with theories of the second tendency.

In the new regionalism, economic integration is not an objective in itself, but serves a higher objective of economic and political nature. Björn Hettne presents the new regionalism as a package of a multi-dimensional process of economics, politics, social and cultural parallel and interrelated processes. It will fill the purposes of new regional and political ambitions of territorial identity, political convergence, collective security and regional coherence. (Asante 1997)

Stubbs and Underhill (1994) identify three central elements of regionalism. First is a common historical experience within a geographically distinct group of countries – a region. Second is the boundary within which more intensive interactions take place – rationalisation. Finally it is the organised legal and institutional design of conscious policy that defines – regionalism. The three dimensions are different in different cases in both spatial variety and to level and extent. (Smith 1997)

Sheila Page (2001) defines regionalisation as a process that a group of countries who have chosen integration by their own will and share a legal framework of cooperation, have extensive economic relations but also express the intention to continue this process by evolve or change. She agrees that countries in regions share common historic traits or background, similar characteristics and trade links, which, she warns, may have implications for the multilateral trade system. The importance of outsiders is considered small but political cohesion and security issues as strong reasons for economic integration. She defines what creates a common interest as geographical closeness, population structure, economic size, political congruence and a common background or sense of community. Therefore, countries

with similar characteristics of resources, climate, organisational structure and religion for example have good prospects of becoming regionalised. (Page 2001)

Regional cooperation is a way to get to regional integration. One key aspect of development strategies is the dynamic potential of regional cooperation and integration. Developing countries need regional grouping of institutions to perform economic decolonisation but economic integration is a gradual process. (Asante 1997) Even though climate, infrastructure, and other factors are contributing to making coherent political action a rational choice several competing political jurisdictions are making it difficult. Notably national sovereignty is making cooperation difficult. (Wood 2003)

Smith (1997) argues that the new phase of regionalism and increased trading and regulatory agreements depend upon the distribution of powers on several levels. There is constant tension between demands of statehood and pressures for collective action and adjustment to regional realities. It is the combination of forces of power distribution, the role of institutions, existence of identities and ideology are the things that make up the regional order. The relation between economics and security also has impact on the functioning of regions and regional orders. However, strong political economic pressure may lead to globalisations of production and exchange as well as awareness of environment and security issues. (Smith 1997)

5.2 The African Context

This albeit limited selections of theories above are by and large state-centric and tend to focus on the inter-state relations, notably in Europe, North America and lately Asia-Pacific. Developing countries and especially in Africa have been neglected in the general theoretical discussion thus far.

Two periods of regionalism in the developing countries are distinguished – new and old. The differences between developing countries' regionalisation process in the 1960s vs. the 1980s were that the old regionalism was an extension of import-substitution industrialisation strategy from national to regional perspective and thereby from inward- to outward-oriented policies. The second difference was that developing countries searched regional integration exclusively with other developing countries whereas now they are building relationships with developed countries, especially in Latin America. (Asante 1997)

In the African economy and political evolution regionalism might have other implications. Bignu WT Mutharica offers an interpretation where regionalism is a *"Process whereby two or more countries in a particular area voluntarily go together to pursue common policies and objectives in matters of general economic development arrangement. In particular the economic field is of common interest to mutual advantage of all the participation's states".* This considered true for regions and sub-regions in Africa. (Asante 1997 p.20)

Andrew Grant and Fredrik Söderbaum (2003) are correcting the prior neglect of Africa. Their works are rooted in the 'the new regionalism/regionalisms approach' (NRA). The approach goes beyond the state-centric focus and integrates discourses of human security and development. Consequently also non-state actors and 'informal regionalism' is considered. The approach is based on the critique against conventional regionalism that does not capture the process of regionalisation in Africa. It regards the state as an actor also promoting it's own

interests and not normatively for public good as described in realist and liberalist theory. The NRA is more concerned with the dynamics of the regionalism process in various fields and at different levels rather than the institutions and trade policy that is usually considered in mainstream research. It is concerned with the content of regionalism rather than the form. (Grant & Söderbaum 2003)

Grant and Söderbaum agree with Hettne *et al.* (1999) that regionalism is a multidimensional phenomenon often driven by several actors from different sectors. They define regionalism in a narrow sense as, *"the body of ideas, values and concrete objectives that are aimed at transforming a geographical area into a clearly identified regional social space. In other words, it is the urge be any set of actors to re-organise along regional lines in any given issue-area."* The process of regionalisation on the other hand is described as an occurrence of cooperation regardless of the ideology support of regionalism or not. (Grant & Söderbaum 2003 p. 7)

Regionalisation in Africa is one aspect of the pan-African movement aiming to *"unification of African forces against imperial and colonial domination"*. The purpose was that it should serve as an *"integrative force as well as a movement of liberation."* (Asante 1997 p. 32) With the creation of the Organisation of African Unity (OAU) the liberation aspects of pan-African integration continentally lost momentum. Recently, African awareness of integration for growth and development has grown and economic integration has become a priority issue in African development strategy. (Asante 1997)

Regionalism has its critics – indeed, it is generally agreed that the optimal policy for any country is unilaterally to liberalise its trade on a most-favoured-nation (MFN) basis, and that regionalism is a second-best solution. (Maasdorp 1999) However, this is valid if regionalism is confined to an economic interpretation. In many developing countries, especially in Africa, there are other reasons for regional cooperation and integration on several policy issues as well. Page agrees that trade politics and the intensity of trade relations is not sufficient to hold an area together. The real gains from trade are uncertain, small and unpredictable in the long run. Therefore other objectives with the cooperation must be significant as well. If the gains of cooperation are unequal then it might be necessary for a party to offer 'payment' of come sorts to another party in order to make the region survive. (Page 2001)

5.3 Economic Integration in Africa

The interest of security in regions and regionalism had raised awareness of regional cooperation and institution building. Regionalism has grown side by side by globalisation of world production and trade expansion. But most of the developing countries' arrangements have turned out failures. One reason was the cooperation was usually based on the sole motive of industrial import substitution. But with the mid-80's rediscovery of regionalism in Europe, Africa and in North and South America new approaches were highlighted, where trade was the most important one. (Asante 1997)

Some of the reasons for regionalism in Africa are 'fortress Europe' (European protection of its own market and subsidies to own industry) that is marginalizing Africa politically and economically. Combined with the pressure from the World Trade Organisation (WTO) and trade negotiations in the trade rounds there is motivation to create a more unified and powerful voice. To appreciate the benefits expected to be derived from trade other social

benefits than economic growth will have to be considered. This has overriding importance for African countries' decisions on whether to cooperate more. Even though economics and politics are separate disciplines they cannot be separated when discussing regionalism but since regional institutions are political in nature, African integration tends to be over-politicised. (Asante 1997)

Several sectors with great capacity for integration in African context are industry, agriculture and energy. Sharing energy resources are particularly suited for enhanced regional cooperation. There is need to ensure the full exploration of hydroelectric energy potential. Foreign direct investment (FDI) has been essential for the execution of sub-regional integration programs and explains why there has been very little progress made in development of hydropower and transport etc. Trade expansion of mutual trade is only possible if African countries are able to produce desired merchandise in sufficient quantities to meet each other's demand. (Asante 1997)

5.4 Water and Conflict Management

The environmental focus is a major development challenge. Sub-regional and continental policies, strategies and programs are needed since environmental problems are transboundary to their nature. (Asante 1997) In 1990's there was a paradigmatic shift where focus was directed from nation-state security towards individual security that included economic, food, health, environmental, personal, community and political aspects. The environment is an important factor of human security but receive relatively little attention because it is not easily measured by social scientists. (Grant & Söderbaum 2003)

David Simon complains that little attention has been paid to environment-development initiatives as opposed to political and economic aspects of regionalisation. Transboundary water sources have received slightly more attention. But he also notes that even in neo-liberal regionalism have more transboundary environmental issues received more attention. This is one difference from the 'old' regionalism of the 1960's to 1980's. Simon defines this mostly as lip service with little genuine commitment – *"sustainability-speak"* (Simon 2003 p.72). On the positive side it conceals a shift to acceptance of environmental problems being transboundary therefore requiring multilateral action. It also entails recognition that environment has effects on human development. (Simon 2003)

Over 40% of the world's population resides in 261 transboundary river basins of which 60 are located in Africa. Therefore the management policies and institutions guarding these are extremely important. Because of future anticipated population growth (global water demand is currently said to double every 21 years), water resources, especially international river basins, have been transformed into tense arenas for competitive exploitation by neighbouring nations. This is because of different national interests and management. In contrast to water conflicts, more than 3600 water-related treaties have stood firm since 805 AD, while in the same period, there have been only seven minor water-related skirmishes. 286 treaties have been identified which settle the management of international rivers. (Kilot *et al* 2001)

Water-scarce countries with high population growth are more vulnerable to internal and external conflicts over scarce water resources especially since water resources all over the world are over utilised and heavily polluted. The evident strategy to correct both the quantity and quality problem is basin-wide cooperation. It is the optimal solution to the problem of

managing international basins. Kilot *et al* (2001) identify two problems that countries sharing international rivers face, the first are to manage the water resource holistically the second to share the source internationally. (Kilot *et al* 2001)

The authors are of the opinion that riparian countries may easily get into conflicts over shared waters in the absence of balanced cross-boundary and cross-sectoral integration. Most countries recognise this problem and have taken steps to regulate such differences. (Kilot *et al.* 2001) But sometimes that entails restriction of state sovereignty. Such is the case of the Nile where an upstream riparian may not take certain actions without down-stream riparian states agree, provided their water supply may be affected. Quotas of allocation and pollution regulate the Nile. However, even if that is a step in right direction it is not much of an international agreement or management practice, neither politically nor environmentally. (Kilot *et al* 2001)

5.5 Virtual Water Trade and Food Security Application

Most African economies are commodity-based. Therefore cooperation in production and trade in food deserves special treatment given the mounting food needs in Africa. Strong support is needed for these projects that in the long-term require need for diversification of production of manufactures and services. This is a slow process and the major immediate priority area of collective self-reliance is food self-sufficiency and security. The expected food crisis has heightened the need for integration in agriculture, first on a sub-regional and then a continental level, to create an African Common Agricultural Policy (CAP). (Asante 1997) Beginnings to this kind of cooperation are found in southern Africa.

Gavin Maasdorp (1998) studied regionalism and food security in southern Africa and found that there are two strong arguments for regionalism in the food security field. First, the primary staple food is white, not yellow, maize. This is the traditional consumer reference throughout the region. The white maize is mostly supplied by South Africa but has to be substituted by yellow maize when there are not enough yields. Maasdorp argues that a free trade area could encourage the development of a regional market, with the most efficient producing areas taking advantage of economies of scale. Second, regional integration can increase food security because of the high transport costs and transport time if imported food from elsewhere. (Maasdorp 1998)

But international commitments have thus far failed to improve food security, at least, in Southern Africa. Problems are blamed on the lack of political will both nationally and internationally. National interests regarding trade and security are prioritised over UN agreements. Developed countries subsidies of agriculture are fiercely criticised for decreasing developing countries' chances of domestic food production. Trade imbalances between developed and developing countries exacerbate food insecurity in the developing countries. But trade agreements on the international stage are still a major part of solution of securing global food security under the condition that trade is fair. (Drimie & Mini 2003)

This includes the geo-political relevance of virtual water. Governments and international organisations should include virtual water accounts as an instrument in any national or regional water and agricultural policy analysis. Joint efforts by governments, international finance institutions and research institutes are needed to analyse the geo-political importance of virtual water. Virtual water trade as a component of water policies is contingent to the rules

of the international market that the WTO today is trying to establish. Current trade climates and conditions are not very supportive for enhancing virtual water trade as option in water policies for especially the poorest countries. Virtual water trade has geopolitical implications. It induces dependencies between countries, is influenced by and has implications in world food prices as well as on the global trade negotiations and agreements on tariffs and trade. In virtual water trade one has to consider the food import requirements of the water scarce countries and the willingness of water abundant countries to produce these products. (WWC 2004)

Middle East and North Africa region (MENA) in particular is subject to distortions of importing virtual water. Vast volumes of water imported in virtual form urgency of local water deficits endured by Middle East and North African political economies can be de-emphasised. (Allan 2003) Conscious policy options are already formulated by some arid countries, notably Israel and Jordan, which enable water saving by reducing export of water-intensive products (crops). The flows of water virtually embodied in food products – have been assessed at 700-1100 km^3/year. Possible liberalisation of trade might double this flow. (WWC 2004)

6. The Nile River Basin

This part of the study provides the empirical experience of the study suggesting that virtual water trade can contribute to regional development in the area. It starts out describing the hydrology of the Nile basin, continuing to explore the opportunities for development of virtual water trade in the region, ending with presenting the road to and the current status of the regional cooperation over the Nile water resources.

6.1 The River Nile

The geological history of the Nile starts some six million years ago. But the river of today is – with a geological time span – recent. The development of the river Nile has gone through several phases in that time. Not until 700 000-800 000 years ago did the Nile actually gain enough strength to go through the Saharan desert all the way to the Mediterranean Sea. The new river (the Prenile) was a vigorous river with enormous volumes of water and silt that were deposited on the flood plain and delta. Some 400 000 years later a less competent river – the Neonile – pushed through the landscape and still is. It developed into a perennial river due to rains in the Ethiopian highlands and the Equatorial Lake Plateau (Lake Victoria and surrounding area) some 10 000 years ago. This is the modern Nile, as we know it today. (Said 1993)

The total length of the Nile is 6 825 kilometres (2 700 km is through Saharan desert), which makes it the longest river in the world. The drainage basin makes out one-tenth area of the African continent but because a large part of the basin is rainless only a small volume of water reaches the sea. The Nile is not just one river; it is a collection of rivers and basins. (See map in Appendix 1) The Ethiopian highland is the source of three main tributaries to the Nile. The three rivers – the Atbara, Blue Nile and Sobat – have steep falls down towards the plains where they meet the main Nile at Karthom. They are highly seasonal rivers with a peak ratio of 40 to 1. Thus the monsoon months of June to October (peaking in July-August) are when 90 % of the annual precipitation falls. Two other rivers water the plains of central Sudan but do not have enough water to reach the main river. This seasonality has made the Nile one of the most predictable rivers of the world. (Said 1993)

6.2 The Countries of the East Nile river basin

The ancient Egypt regarded the rise and fall of the Nile as divine as the rise and set of the sun. However, the Egyptians later knew the flood of the river came from Ethiopia. Connections between the countries were frequent mostly due to trade along the Red Sea coast. The Egyptians even sent messages to the Ethiopian king in years of low flood and gifts were sent sweetening the King to allow the flood to flow into Egypt. (Said 1993)

Since north-eastern Africa receives little precipitation and therefore irrigation was very important for its settlement. The productive lands along the Nile received natural irrigation and fertilisation by the floods. (Cech 2003)

Ethiopia
Ethiopia is a country dependent on rain-fed agriculture to sustain its fast growing population. Population growth in Ethiopia is high and projections show that it will outgrow Egypt by 2025. Both Ethiopia and Egypt are expected to be water scarce by 2025. (Brunnée & Toope 2003)

Current energy needs in Ethiopia are covered by fuel wood. Therefore large areas of forests are being cut resulting in soil degradation. (ADF 2003) Hydropower in Ethiopia has great capacity to develop its potential in the coming decades, especially smaller developments. (Wichelns *et al* 2003) The large untapped hydroelectric potential is estimated to 30 000 MW of which only 2.23 % is exploited. (ADF 2003) This amounts to as much as three times the electricity generated at the Aswan High Dam in Egypt. (Whittington *et al* 1995) The country is still a net importer of both oil and food. The food supply in Ethiopia is not much affected by the Nile flow since its agriculture is still mostly rain fed. This is likely to change in near future because of population growth and a stable food supply will be necessary. (Brunnée & Toope 2003) Only a small fraction of Ethiopian agricultural soils have received irrigation. Still the country is a net exporter of coffee, which accounts for more than half of total export value (1999-2000). (ADF 2003)

Egypt
As the Egyptian population grew more food was needed and controlled irrigation was invented. The growing of power and wealth of the Egyptian kingdom depended on the development of irrigation that increased food production and thereby tax revenue. (Cech 2003) The water available to Egypt is barley sufficient to satisfy current needs and land reclamation schemes are pessimistic even though necessary with the growing population pressure. Eighty-five percent of total water use is used for agricultural purposes in Egypt. Almost all of Egypt's population lives in the vicinity of the Nile making out 4 % of the total land area. The river is extremely important to the country as its agriculture is completely based on it as source of irrigation. (Said 1993)

Egypt's GDP estimates to the double of the southern neighbours but have large income gaps. Its agricultural activity is dependant on irrigation and faces problems of salination. The Egyptian government have large plans on land reclamation projects, one of which is in the southern desert. Egypt's agricultural developments have resulted in shift from cotton to rice production, which has market set prices and demands much more water in production. Since Egypt has already pursued its irrigation potential the country will probably be more dependent on food imports in the future. Agricultural developments will probably be directed towards more high-value crops such as horticulture possible to export to Middle East and European markets. (Wichelns *et al* 2003)

It has also used the river for hydropower purposes building the Aswan high dam creating the reservoir Lake Nasser. But Lake Nasser is responsible for the rapidly increased loss of water to evaporation in the basin. New reservoirs in Ethiopia would reduce the evaporation loss from lake Nasser by 50 % that means savings of 4-5 billion m^3 per year in crude estimates. (Whittington *et al* 1995) Ten percent of the Nasser reservoir evaporates, which is equal to the total withdrawal of water for household and commercial use throughout Africa. Utilisation of the river's flow across the region has resulted in disruption of perennial variation of the system. Declining water quality from industry, agriculture and domestic use affects public health, productivity of resources and quality of life. Upstream soil degradation affects the levels of silt in the reservoirs reducing their capability to produce energy and flood control.

(ADF 2003) As much as 98 % of the nutritious sediments fall to bottom of Lake Nasser severely affecting its capacity of flood control and mitigation of droughts. (Wishart *et al* 2000) Furthermore, since it was built only 2 percent of the water reaches the Mediterranean Sea, which has caused ecological crisis and poor water distribution. (Brunnée & Toope 2003)

Sudan
In contrast to Egypt, Sudan, the country with the largest reserve of cultivable land in sub-Saharan Africa, has not pursued its irrigation potential. Fertile soils are located in the south-eastern part of the country between the White and Blue Nile. Infrastructure investments in that part of the country have long been obstructed by civil war. The government does not traditionally prioritise agricultural support. (Wichelns *et al* 2003) Sudan's economy is also agrarian and depends on the Nile for irrigation purposes. However, it has been restrained in its use of resources by Egypt as will be explained later on. Sudan has in later years been exporting oil and has limited and even diminishing hydropower potential, since its reservoirs are also being filled up with silt from the Ethiopian soil erosion. (ADF 2003)

6.3 The Road to the Nile Basin Initiative

The Nile basin is a classic example of resource competition for resources, intensified by historical and legal factors and political dynamic. Treaties made up between the countries by their colonial powers have regulated the region's water resources ever since.

The British gained hegemony over the whole of Egypt and parts of Sudan in the Berlin conference 1884. They set out making agreements with the neighbouring powers over the Nile. By 1906 there were agreements between England and Italy and France protecting the flow into the Egyptian Nile. An agreement from 1902 between Great Britain and Italy (on behalf of Ethiopia) stated that Ethiopia would not in any way obstruct the flow of waters into the Nile. (Said 1993)

By 1929 the Nile Waters Agreement was reached. It restricted the Sudanese water use and gave Egypt veto right of the British colonies along the Nile. When British hegemony over the region ceased, newly independent Sudan wanted to build a dam in the Roseiras of southern Sudan thus rejecting the 1929 treaty with Egypt. This almost ignited a war between the two states. Instead under large diplomatic pressure a new treaty came about in 1959. The new treaty was still largely on Egypt's terms but allowed Sudan to go ahead with the dam construction, but was halted anyhow by civil war breaking out in the South of Sudan. Still, Egypt got the stability needed to build the Aswan high dam. Ethiopia never recognised the 1959 treaty and has persistently claimed sovereignty over its resources. (Brunnée & Toope 2003)

Several activities that were overlapping have led up to the new developments of Nile Basin Initiative. Hydro-meterological studies were launched in the 1980s where Egypt and Sudan were participating. The UNDUGU (Swahili for brotherhood) was set up in Egypt 1983 with all the Nile riparians as members except for Kenya and Ethiopia who were just participating observers. The purpose of UNDUGU was to foster economic, social, cultural and technical ties between the countries. The end result was to be a permanent sub-regional economic organisation. Not much substance came out of it. (Brunnée & Toope 2003)

However, in 1992 the intergovernmental Technical Cooperation Committee for promotion of Development and Environmental protection on the Nile (TECCONILE) was created. It was to have strong technical focus - Kenya and Ethiopia again participated as observers. The TECCONILE negotiated the Nile River Basin Action plan, which was approved in 1995. It was revived again in 1999 revised as the Nile River Basin Strategic Action Program and the Nile Basin Initiative (NBI) replacing the TECCONILE as organisational framework. (Brunnée & Toope 2003)

All the same tension has continuously been high during negotiations, carrying threats between the countries of the region. Egypt has been outspoken in its claims that the obstruction of the waters of the Nile to reach Egypt will be seen as a threat to its national security and will be met with force if necessary. Sudan and Ethiopia have accused each other for supporting enemies of the respective governments. Egypt's president Mubarak was exposed to an assassination attempt in 1995 in Addis Ababa. (Wichelns *et al* 2003)

Resulting from these events regional distrust became widespread and mutual. Until recently only few integrative actions or interests have been displayed, i.e. UNDUGU and TECCONILE. The economies are disconnected and trade patterns are following traditional patterns with formal colonial powers instead of poor developing countries. The interest in the Nile River is also disparate. While Egypt regards Nile water of vital interest it is of lesser importance to the other states especially Ethiopia. Poor insight of the problems of population increase and resource pressures resulting from the lack of basin-wide sharing of information when developing national water plans has led to Egypt getting the upper hand in negotiations situations (Brunnée & Toope 2003)

There is no international law to lean on for guidance but the few ongoing activities that led up to the Nile basin initiative has established patterns and norms. (Brunnée & Toope 2003) Only in very recent years have the tension been eased. A general cooperation agreement signed between Egypt and Ethiopia, the parties agreed not to exploit the waters of the Nile in such way that could harm the other country. (Wichelns *et al* 2003)

6.4 Nile Basin Initiative

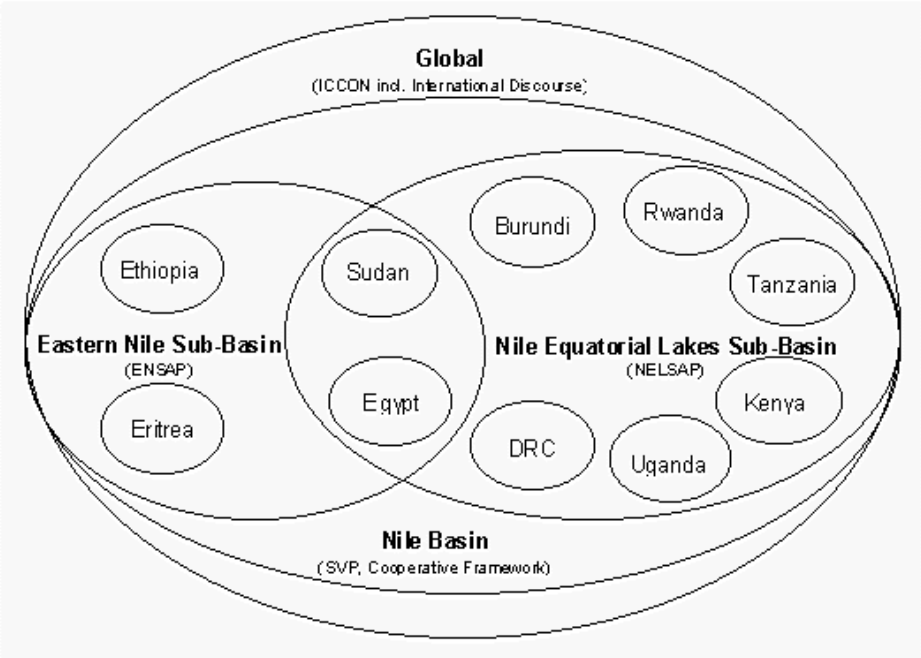
A new way of dealing with this tension came about in the Nile Basin Initiative (NBI), a cooperation platform with a shared vision of managing the Nile resources in a sustainable and equitable way. The ten countries, of the whole Nile river basin, have agreed on a Shared Vision: *"To achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources."* There is a Strategic Action Program to make this vision come true. Here the *shared vision program (SVP)* offers the framework for activities carried out in *the subsidiary actions program* that has been set up to implement the vision. The two sub-programs are supposed to be mutually reinforcing. (Msuya 2001)

The subsidiary action programs are divided between the two major groups of countries making out the sub-basins. The subsidiary programs are the *Nile Equatorial Lakes Subsidiary Action Program (NELSAP)* and the *Eastern Nile Subsidiary Action Program (ENSAP)*. The NELSAP includes Burundi, Democratic Republic of Congo, Kenya, Rwanda, Egypt, Sudan, Tanzania, and Uganda while ENSAP includes Ethiopia, Egypt, and Sudan, while Eritrea

participate an observer. (ADF 2003 see figure 6.1) Here we concentrate on the ENSAP since it concerns the states in the study.

The country activities take place in sub-basin frameworks, which occur within the broader context of the basin-wide framework. This includes an international discussion on the sustainable development and management of Nile waters. How this relates to each other is displayed in figure 3 below. (Msuya 2001)

Figure 6.1 Relations between the Nile Basin Initiative components (As illustrated by Msuya 2001)



The long-term objectives of the ENSAP are to:
"Ensure efficient water management and optimal use of the resources through equitable utilization and no significant harm;
Ensure cooperation and joint action between the Eastern Nile countries seeking win-win goals;
Target poverty eradication and promote economic integration; and
Ensure that the ENSAP results in a move from planning to action." (NBI website)

Among the initial focus areas of the ENSAP are integrated water resources management (IWRM) and hydropower development and trade. Other focus areas deal with water quality, irrigation and regulation. The end result will hopefully be greater regional integration with benefits cutting across all sectors of society. (NBI website) the ENSAP contains an operational vision where the co-riparians will be strong, globally competitive economies working together by 2020. The key to this goal is to develop through *"economic integration through joint physical, social and economic infrastructure."* In this vision the river Nile serves an important role as the common ground of understanding and cooperation. (NBI website, 6th ENCOM Meeting 2001)

Several projects have been identified for initial focus of the Eastern Nile subsidiary program. These priority projects, known as the Integrated Development of the Eastern Nile (IDEN) were selected for their possible contribution to 'win-win' solutions and a regional integrated framework. (ADF 2003)

An area identified for cooperation is Integrated Water Resources Planning and Management where one of the development objectives is to *"Strengthen the capacity of Egypt, Ethiopia, and Sudan to identify, prepare, and implement cooperative development projects that provide mutual benefits in the Eastern Nile."* The Immediate objective is to develop a planning model as part of the planning process for the sustainable management of the waters. Another objective is to *"Promote social and economic development in the region in an environmentally sustainable manner"*, through multi-purpose development of the Sobat river basin. (NBI website)

6.5 Virtual Water Trade in the East Nile River Basin

Dennis Wichelns *et al.* (2003) presents a conceptual framework for cooperation in the Nile river basin. Cooperation will help countries achieve not only their domestic goals but also enhance regional net benefits. Water is recognised as one of the important resource endowments, which is input generating social benefits. Others are energy resources, labour and investments. (Wichelns *et al* 2003)

Water is an input directly to agricultural and industrial production. It also provides ecosystem services throughout the basin. Food security, national security, economic growth etc. are described as social net benefits for the countries. If the expansion of water supply enhances food security it increases social net benefits, but so does virtual water trade shifting farm policy to high-value crops. All nations could increase social net benefits by implementing mutually beneficial agreements that involve Nile River water and other productive resources. (Wichelns *et al* 2003)

Exploring its comparative advantages, the countries may identify their area of cooperation. Reviewing the key production inputs of land, labour, water and energy, the authors suggest that Sudan's irrigated area could be expanded, at the expense of Egypt and Ethiopia. But since Ethiopia has limited potential for irrigated agriculture because of its topography, they are better off developing their hydropower potential, reducing evaporation losses and increasing electricity availability domestically and regionally. Sudan may have better crop yields than Egypt, as may Ethiopia. The abundance of labour in Ethiopia and land abundance of Sudan argues for trans-border cooperation that will improve rural incomes and enhance food security. (Wichelns *et al* 2003)

Egypt has a comparative advantage in the production of high-value crops for export to European and Middle Eastern markets. According to the authors, the sum of net benefits in the region could be increased if Egypt reallocates some of its water from the production of grain crops to higher-value fruits and vegetables, while Sudan increases its production of rice and traditional crop - sorghum. Egypt's agricultural water demand decline if a shift toward horticulture takes place. Sudan may increase cotton production while the textiles factories be located in Egypt. A market for goods would hopefully grow on its southern border where high-value products such as fruit and vegetables as well as textiles would be exchanged for grain, rice and cotton at affordable prices. The authors also predict in their long-term scenario that Egypt and Sudan might offer their support for water resource development in Ethiopia, provided they would get favourable energy contracts. The authors view the implementation potential of the scenarios as small but are of the opinion that cooperative agreements over other inputs than water will be necessary for sustainable economic development in the region. (Wichelns *et al* 2003)

7. Exploring the concept of Virtual Water Trade

In this part the regional development of the Nile river basin - or rather part of the basin – is reviewed in the light of the theories presented in the previous chapter.

7.1 Structure of analysis

Closing in on the dimensions of sustainable development in a regional development and water context, integrated water resources management (IWRM) stands out as the conceptual framework for future water science and policy making. A holistic approach to water and food scarcity will benefit not only water science but other disciplines preoccupied with development issues as well, notably development studies and regionalism studies. Within these disciplines strands of characteristics were identified that may benefit the interdisciplinary future of virtual water concept.

The review of literature has helped identify characteristics of virtual water trade as applied in the disciplines. The challenge is now to combine these characteristics to enhance the interdisciplinary of the virtual water concept. In Giovanni Sartori's words, it is time to climb 'the ladder of abstraction' to enhance the possible benefits of the concept to the theories discussed in the previous part of the paper.

This part will therefore first examine closer the virtual water trade model and its application as described in the environmental, economic and social dimensions of sustainability. These applications will be combined to expand the concept of virtual water trade and its applications from different perspectives. Thereafter the expanded concept will be applied to the region of the East Nile river basin. The study area presented above offers an example of regional development. Possibly can virtual water trade enhance the development process in the region.

7.2 The Application in Water Science

The traditional hydrologic cycle does not make difference on blue and green water, all rainwater is considered combined as runoff. Evaporation and transpiration is combined into evapo-transpiration. This approach does not consider fully the properties of the water flow in biomass production. When considering blue and green water separately the different uses for water become important. Green water is important for rain fed agriculture whereas blue water is the source for irrigated agriculture. This division has implications for food security since the blue water bias concentrates all efforts - economic, political and engineering alike - on possibilities for increasing irrigated agriculture. The blue water use for irrigation competes with alternate uses of water such as water for ecosystem services, industry and household use. The alternative uses of water decide the opportunity cost of water. Regarding green water use in a basin area would perhaps benefit not only the opportunity for cheaper rain fed agriculture but also reduce pressures on blue water resources. However, green and blue water are mutually competitive, increasing the green water will reduce blue water. This is true when considering quantity. The quality of the blue water may be enhanced increasing green water flow. Biomass filtrates water and participates in flood control and soil degradation.

7.3 The Application in Trade Theory

The virtual water trade concept derives from neo-classical trade theory. Therefore it follows the line of reasoning inherent in that theory. The dilemma is not so much about the supply of water but rather allocation and use of water. Domestic water markets are one area of study, which occupies economists. Virtual water trade is instead directed towards the transboundary allocation of water. Here water is one resource used as input in production, what kind of production decides the opportunity cost of water. However it is important to be clear on this point. Comparative advantage is where the country has a production advantage the opportunity cost of production is low, *in comparison* to other countries.

Hence, the opportunity cost of water is of great importance for virtual water trade. If a country has endowments of water that renders it a comparative advantage that country may trade in virtual water. Trade generates income for the country engaged in trade and benefits the country it trades with. In this case the countries engage in food trade that in effect enhances food security. Thus allocating not only water more efficiently but also food, which is an important side effect of trade besides the raising of national income.

The importance of virtual water trade is in this context regarding the general cooperation required for trade and for inter-basin resource allocation. As noted above the cooperative mode set by existence of trade benefits regional cooperation. For developing countries it is nearly impossible to plunge in to the world market for agricultural products (not least because of agricultural subsidies in the developed countries, keeping world prices low). However, this does not rule out the possibilities of creating regional markets that may expand and benefit the whole region making it rise to world competition.

Trade thus stimulate economic growth and contribute to food security and cooperation. Cooperation is a prerequisite for trade but also generates and deepens cooperative activities. Countries engaged in trade have fewer tendencies for conflict. The importance of virtual water trade can be said to have effects on the general development of the whole region.

7.4 The Application in Regionalism

As Sheila Page argues above in chapter five, trade is not sufficient reason for cooperation - other objectives are necessary. Economics and politics are closely interlinked when discussing regionalism. The previous section has already covered some of the benefits of trade here we will concentrate on the non-trade arguments for regionalism.

Since most African economies are agrarian, this is the sector in need of attention. The expected food crisis requires a holistic approach that does not decouple national security issues. One such issue is food security. It is both a result from and a contributing factor to national insecurity. African countries have thus far concentrated efforts in agricultural policy to self-sufficiency. The reason is non-exiting regional markets and tariff regulation but also insecurity in relations to neighbouring countries both over political issues and resource allocations.

Conflicts arising as result of resource allocation require new ways of dealing with problems. Mutual understanding of respective needs is essential and preferably derived through

constructive dialogue. The large agrarian use of water may be mitigated through allocation agreements. These agreements need to be respected by the parties and reached in a secure surrounding without interference from threats of violence. Empirical experience points to that violent conflict over transboundary water resources are unlikely but quarrel over resources may very well dismay other cooperative efforts.

The exchange of agricultural goods, energy, and other commodities will enhance not only food security but cooperation all over as well as generate economic growth. This will benefit the regional development from a security and human perspective as well.

7.5 The Combined Application

Keeping analysis on a rather general level these applications may be combined. Such an effort will be attempted here. Starting out with the natural aspect, precipitation divides into green and blue water. The green water engages in biomass production, agriculture and otherwise, returning to the atmosphere through plant transpiration. Assuming contribution in agricultural production it contributes to increased food security.

The Blue water has two major uses, agricultural irrigation that also increases food security, and alternative human and ecosystem uses. Concentrating on the human activities three major uses proliferate. Household use is very important but contributes less to economic growth than industrial uses do. Hydropower use is very important in a region with growing energy needs both for household use and industry. These complexities and balances decides the opportunity costs of water.

The opportunity costs compared between countries decide their respective comparative advantages. It is not based solely on resource endowments but on the uses of the resources. The comparative advantages decide which commodities the countries will engage in trade with. Since all commodities in one way or another are more or less water intense in production countries will engage in virtual water trade. Especially food commodities are water intense and those from irrigated agriculture in particular. Virtual water trade can therefore relive pressure on irrigation and thus on the blue water resources. This will in its turn have repercussions on the opportunity cost.

Trade is not possible without some kind of cooperation. Especially favourable trade agreements that benefit both parties are not possible unless cooperation. Cooperation in its turn benefits trade. Spillover effects from trust generated by iterated cooperation on any subject will enhance feeling of national security reducing tension and potential of conflict in an area. National security is also enhanced by food security for the growing population. Political tension has been over the blue water quantities thus far and therefore the blue water quantity is important to the national security of a country.

Regional cooperation in this setting was defined in the introductory chapter as: water and food security, economic growth based on international trade as according to the neo-classic economic paradigm and regionalism in the African context.

In this combined application of the virtual water trade concept, it is demonstrated how water and food security, trade through economic growth and national security are increased by

virtual water trade thus contributing to regional development. If this is true in the case illustrating the point is examined in the next section.

7.6 The Application to the East Nile River Basin

The processes and links projected in the previous section are not as clear-cut in the area of study. However, there are traits that might explain some of the recent developments in the Eastern Nile area and point to some possibilities of the future.

Starting with the hydrology facts of the basin we know that there are climatologically differences between the countries. Roughly expressed, Ethiopia receives all precipitation and Egypt none. Sudan's reality is somewhere in between. Ethiopia is the upstream riparian and Sudan and Egypt the downstream ones depending on the Nile flow let through by Ethiopia. Egypt and Sudan are drought prone areas with more or less fertile soils. Water is the restricting means of agricultural production in these two countries. Ethiopia's restricting factor is instead arable land. The topography of the country hinders efficient irrigated agriculture but increase in agricultural production is possible. Green water is decreasing because of deforestation. This has effects on the quality of the blue water in the rivers. The silt decreases the capacity of downstream dams generating electricity and flood control. Thus letting Ethiopia develop its hydropower potential would have positive effects in that respect. Less soil degradation thus less silt in the reservoirs downstream. However, the reservoir developments in Ethiopia would obstruct the water flowing downstream for hydropower use and irrigation purposes. Thus, downstream riparians would have to be offered something in return. Such as beneficial electricity agreements, sharing the profits along the basin.

This would require cooperative measures from the countries and mutual trust that agreements would be kept in the future. The instability of the region in the past does not encourage such suggestions. Mutual distrust has characterised the relations between the countries thus far. Few bilateral agreements on water resources have been developed and kept. Those that have, have been partial to Egypt, thus not reflecting hydrosolidarity or equal rights to resources. The countries have few informal ties for example trade relations. Existing trade patterns reflect ties with former colonial powers and regional market does not exist to any organised extent. Thus the lack of cooperation over such non-security issues reduces the chances of mutual understanding and spill over effects on formal cooperation.

However, some non-security activities have benefited the formulation of the current Nile Basin Initiative, two stands out. One larger activity has been concerning technical cooperation and the other aiming towards sub-regional economic organisation the UNDUGU. Despite the lack of substance in the UNDUGU it fostered mutual understanding and vision of regional cooperation suggesting that the link between trade and regional development holds. The other cooperation that significantly contributed to the development of current state of regionalisation was the TECCONILE. This technical cooperation early engaged in a normative discussion on the future of a legal framework for the Nile cooperation. This is believed to have fostered the identities and shape of the current framework. (Brunnée & Toope 2003)

The current framework of the Nile Basin Initiative (NBI) is characterised by the shared vision *"To achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources"* expressing values align with the

IWRM framework. The action program is substantiated by the subsidiary principle of several sub-programs and parallel development of the political and scientific processes. Still, the NBI is just a temporary framework in the preparation of a binding legal document stipulating new allocation of the Nile resources.

The turning point seems to have been the new cooperation mode of Ethiopia. Being merely an observer in the prior activities Ethiopia has changed attitude participating fully in the new agreement. International pressure, relief from war with Eritrea, and motivation from future funding of development projects have probably contributed to them taking the step full out. Whether the NBI will prove contributing to lengthy cooperation fostering trust between the parties only future can tell. But if it does it will definitely benefit the regional development in the region.

Virtual water trade in the region has so far not proved to contribute directly to regional development in the region. The reason is first of all the lack of a regional market. Without functioning local and regional markets opportunity costs or comparative advantages cannot be established properly. The market place is not just where goods are exchanged it is as much where information is gathered about prices and values are established. Well functioning markets like that are not presently existing in these countries. Egypt presumably has the most well defined market especially for agricultural goods, but the place of exchange is Europe and Middle East. In comparison to the Middle East, Egypt's water comes cheap, considering both comparative advantages and conflict proneness. However, on a basin-level scale which is the relevant scale for water resources management, Egypt's water is expensive comparatively. However, the use of the resources are the determinant of opportunity cost. Thus if Egypt were to use its limited resources more effectively the comparative advantages might sill be to its favour. For example if limited resources of Nile water was used as production input in high-value crops such as horti-culture instead of low-value and water intensive crops such as cotton or rice, it could increase the value of the input water. Increasing the water used in industry (textiles for example) would also increase the output of water use since it produces manufactured goods that are usually are considered step up on development scale.

More water intense (and space intense for that matter) agricultural products would be more efficiently produced in a less dry climate, reducing loss from evaporation, and benefiting from possibility of rain fed agriculture. Especially southern Sudan has these qualities as does Ethiopia where rain fed and irrigated agriculture could be expanded largely for domestic purposes. However, the stability of this conflict ridden country will decisively reduce infrastructure funding and other possibilities in Southern Sudan where fragile peace recently has been reached between locals and the government.

More possible in near future is the funding and development of hydropower in Ethiopia. African Development Bank (ADF) and other development agencies are hoping for the current positive cooperative climate among the countries of the basin prevails for funding to be possible. (ADF 2003). The picture painted by the virtual trade model and scenarios by Wichelns *et al.* (2003) show how the region would enhance development if Ethiopia would produce the power, Sudan the food and Egypt would let them satisfied producing manufactured goods for other markets. However, the authors are not very positive regarding the feasibility of the scenarios. Too many obstacles and uncertainties are still present in the region.

8. The exploration of the Virtual Water Trade Concept

The major limitations of virtual water trade as a model of regional development and indicator of interdisciplinary are the inherent paradigmatic assumptions of theory. Theory from different disciplines tends to have different paradigmatic perspectives. In this study three disciplines have been touched upon and in accordance to the first objective of the study to explore the interdisciplinary traits of the concept of virtual water trade. I will here provide a discussion on the possibilities to link virtual water trade to regional development as expressed by water and food security, economic growth through trade and regional cooperation.

If the links are possible the study will have illustrated the importance and possibility of connecting known theories to shed new light on a concept beneficial to sustainability science and policy options. However, there are difficulties making such a conclusion.

One of the difficulties arises because of the character of the virtual water trade model itself. The virtual water trade model still relies on neo-classical trade grounds. It is still inherent with all the problems of that paradigm which in theory makes it incompatible with paradigms of sustainable development perspectives such as integrated water resource development. Neo-classical trade theory is not based on limits to growth, rather it is occupied with making resource allocation as efficient as possible. This might still have the same effect since the limits to growth approach is also restricting use of resources. If this difference matters in empirical studies is worth considering in a different study .

Most trade theory is still formulated in formal explanations of comparative advantages not considering the reality of developing countries' markets (to the extent they actually exist). Resource endowments are still important deciding opportunity prices but comparative advantage is not automatically contributing to efficient resource allocation from an environmental perspective. Larger considerations to the hydrological cycle and land and water management need to be considered by the model to reflect hydrological realities. The virtual water trade model treats water as any other commodity but considering the incredible importance of water to all aspects of life, human and non-human, question arise whether it needs special treatment. This question is addressed by the debate on the existence of water markets. However, sadly this debate seems to be dominated by ideology and normative assumptions rather than actual research. Unfortunately this study has not been able to reflect this discussion.

Another reason to comparative advantages inefficiency to explain real trade and trade patterns is the neglect on trade theory's part of current and historic politics. Neo-classicists are assuming limited state interaction but in reality state activity have large implications for trade, not the least which trade partners to choose. In the case of East Nile region pre-colonial trade was confined to the Red Sea and its coast suggesting important trade relations between Egypt and Ethiopia. More extensive trade generated by colonialism created trade patterns still followed today. The relation between cooperation and trade is probably very strong but regionalism is not very developed in the African context. The existing one usually regards conflict management. Also the substance and future of the Nile Basin Initiative remains to be seen.

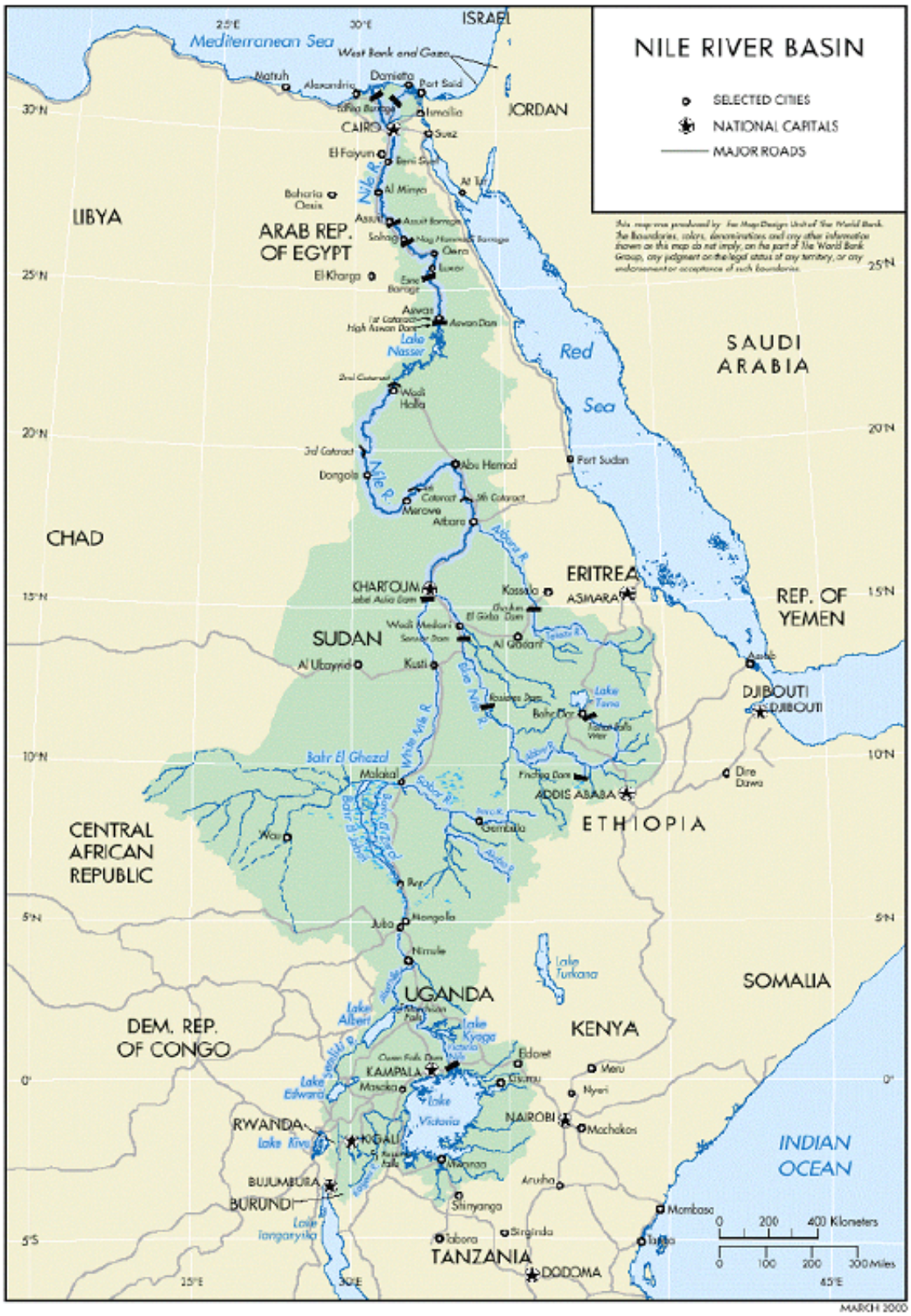
The failure of regionalism and trade theory presented here to discuss or even consider green water or rain fed agriculture as a possibility to increase food production will have to be

explored carefully in future. Will there be implications on virtual water trade if green water was considered for food production and for opportunity costs? Will there be implications for future allocation agreements in the future?

Questions like these are generated by the integrative approach of IWRM. Important to remember about IWRM is that it stems from sustainable development perspective and is easily advocated as something 'good'. It has large possibilities contributing to 'sustainability-speak'. IWRM easily catch on with those already concerned with sustainable development (and who is not today?). Yet, the normative stance of IWRM might actually scare off the integrated research it is aiming to promote.

Virtual water trade has as a concept been explored in regards to its interdisciplinary benefits and applicability to a water scarce region. It is inherently an economic concept tightly fastened in the neo-classical trade discipline, which creates difficulty to use it in an interdisciplinary context as yet. Until the characteristics of the concept are expanded I doubt it will be useful in real policy debate in its current form. The links displayed in the analysis are just too weak still to be of use. However, exploring the concept of virtual water trade across disciplines has rendered much thought on the obstacles to interdisciplinary research. And hopefully to readers as well.

Appendix: Map of Nile River Basin



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