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Virtual Water Trade

A realistic concept for resolving the water crisis?

Lena Horlemann / Susanne Neubert

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German Development Institute (DIE)

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Brüntrup, M. (2005): Ökonomische Überlegungen zum virtuellen Wasserhandel [Economic reflections on Virtual Water Trade], German Development Institute (DIE), Bonn

El-Naser, H. (2005): Virtual Water in the MENA Region, Ministry of Water and Irrigation, Jordan.

Hoff, H. / M. El-Fadel / M. Haddadin (2006): Reply to the Expert Statement on Political Factors of Virtual Water Trade by Hazim El-Naser, Potsdam Institute for Climate Impact Research (PIK), Potsdam.

Hummel, D. (2005): Wasser und Ernährungssicherheit: Was sind die demographischen, institutionellen und sozio-kulturellen Bedingungen für virtuellen Wasserhandel? [Water and food security: What are the demographic, institutional and socio-cultural conditions for Virtual Water Trade?], Institute for Social-Ecological Research (ISOE), Frankfurt

Kluge, T. / S. Liehr (2005): Anpassungsmodalitäten, Regionalisierung und Skalenübergänge im Konzept des virtuellen Wasserhandels [Adjustment procedures, regionalization and up- and down-scaling in the concept of Virtual Water Trade], Institute for Social-Ecological Research (ISOE), Frankfurt

Malzbender, D. (2005): The Political Implementation of the "Virtual Water Trade" Concept, African Water Issues Research Unit (AWIRU), University of Pretoria, South Africa

Meissner, R. (2005): Virtual water trade strategies for an industrialised and a developing country: The case of South Africa and Zambia. University of Pretoria, South Africa

Partzsch, L. / P. Schepelmann (2005): The environment. Environmental Policy Research Centre, Freie Universität Berlin / Wuppertal Institute for Climate, Environment and Energy, Wuppertal

Treitler, R. (2005): Water Allocation and Water Policy. ExAquaResearch (EAR), Amstetten, Austria

Youkhana, E. / W. Laube (2006): Virtueller Wasserhandel und Konflikte um Wasser [Virtual Water Trade and conflicts over water]. Center for Development Research (ZEF), Bonn

Preface

This study is the outcome of the research project "Virtual Water Trade – A realistic concept for resolving the water crises in developing countries?", which was carried out at the German Development Institute (DIE) by Lena Horlemann under the supervision of Susanne Neubert from July 2005 to February 2006.

The concept of "Virtual Water Trade" provides a trade policy approach to resolving the global water crisis. Views on this concept vary widely in the international debate, but it is steadily gaining in importance. Besides seeking to provide the BMZ with a basis for the adoption of its own position on the subject, the study therefore sets out to describe the international debate and to differentiate the various views expressed.

In the study the issue of Virtual Water Trade is for the first time examined comprehensively, i. e. in a multidisciplinary form, with different positions and deployment scenarios included. The study thus makes an original contribution to the international debate.

The study begins by explaining the concept of Virtual Water Trade, its objectives from different angles and its practicability. The arguments for and against are then presented. After these arguments have been sifted and the possible implications and consequences weighed, an attempt is made to gauge the importance which is or, according to the authors, should be attached to the concept. Finally, the discussion turns to the possible future relevance of Virtual Water Trade to various regions of the world and the contributions which development cooperation can potentially make.

The study is based on the existing literature on the subject of "Virtual Water Trade", which has been compiled primarily at the *School of Oriental and African Studies* (SOAS) in London, *Delft University* and the *African Water Issues Research Unit* (AWIRU) in Pretoria. In addition, ten expert statements on specific aspects of Virtual Water Trade were commissioned (see first page), and two expert workshops attended by international specialists were held at the DIE on 6 September and 7 December 2005.

We would like to take this opportunity to express our sincere thanks to the authors of the statements and the participants in the workshops, at which the concept of Virtual Water Trade was the subject of discussion.

Bonn, December 2006 Lena Horlemann / Susanne Neubert

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Abbreviations

AWIRU	African Water Issues Research Unit
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (Federal Ministry for Economic Cooperation and Development)
CO_2	carbon dioxide
EAR	ExAquaResearch
EU	European Union
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
ha	hectare
HDI	Human Development Index
IHP	International Hydrological Programme
ISOE	Institute for Social-Ecological Research
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
LDC	Least Developed Country
MENA	Middle East and North Africa
MFA	Material Flow Analysis
NGO	Nongovernmental Organisation
OECD	Organisation for Economic Co-operation and Development
PIK	Potsdam Institute for Climate Impact Research
SADC	Southern African Development Community
SNA	Satellite National Accounts
SOAS	School of Oriental and African Studies
UNESCO-IHE	United Nations Educational, Scientific and Cultural Organization – Institute for Water Education
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USA	United States of America
US$	US-Dollar
WCD	World Commission on Dams
WPI	Water Poverty Index

WTO	World Trade Organization
WWAP	World Water Assessment Programme
ZEF	Zentrum für Entwicklungsforschung (Center for Development Research)

Summary

1 Aim and focus of the study

The aim of this study is to give a detailed picture of the current debate on the Virtual Water Trade concept from the viewpoint of various disciplines. It thus lays multidisciplinary foundations for a more differentiated and objective debate on the subject. It is also intended as a basis for the Ministry for Economic Development and Cooperation (BMZ) to develop its own position within the broad discussion which is currently in progress amongst circles of experts and on many international conferences on water policies.

The concept of Virtual Water Trade is based on the idea that water-poor developing countries are increasingly importing their food from water-rich countries in order to conserve their own water resources and use them in other, more productive areas where more value added per volume unit of water is generated.

The aim of Virtual Water Trade is thus to compensate for water shortages through the geographical shift of agricultural production and the sectoral shift of water consumption.[1]

Even if the debate conducted in this study sometimes creates the impression that the concept of Virtual Water Trade must be either endorsed or rejected, this is not so in reality. It is rather a case of a progressive and imperfect adjustment to scarcity, approaches which are already to be found in reality and whose continuation might be promoted externally to a greater or lesser degree.[2]

1 However, some participants in the debate also include in the concept of virtual water trade the possibility of continuing to use conserved water resources in agriculture, though for the growing of higher-value crops, i. e. those intended primarily for export, which usually generate a higher value added per unit of water by volume, even though they require far more water per kilogram of product.

2 The debate on virtual water trade must be viewed in the context of globalization and of global economic and environmental governance, where prognoses are considered that are afflicted with considerable uncertainties. Virtual water trade also forms a firm part of the debate on problems and opportunities presented by globalization in general and on the WTO negotiations in particular.

2 The variants of Virtual Water Trade

Virtual Water Trade already occurs today, though not necessarily under that name. An average of 987 km^3 of virtual water was traded annually in the form of agricultural products between 1997 and 2001.

As a result, about 8 % less water was needed globally than if the same products had been grown locally, since different quantities of water are consumed in different climatic zones to produce the same quantity of agricultural products. Although it is not, strictly speaking, possible to conserve water at global level, since also the water consumed by plants is recycled via the water cycle, i. e. precipitation, some proponents nonetheless refer to the exploitation of this "conservation effect" when discussing the advantages of the concept.

Variants of the concept, on the other hand, concern trade in food within a region or a country.[3]

The aim of these conceptual variants of Virtual Water Trade is not therefore the absolute, global conservation of water, but spatial compensation for shortages and the most efficient use possible of water.

Of particular interest in the present study are these last two variants and the potential associated with them, since it is not the absolute quantity of water that leads to the water crises, but its unequal geographical distribution. The scarcity of water is accordingly not a global, but a local to, at most, regional problem.

Also considered in this context are the countries or types of country affected by water scarcity, the question being how important the concept of Virtual Water Trade might become for them, what requirements they must meet for its implementation and what consequences they must expect.

3 Findings of the study

The expansion of Virtual Water Trade must satisfy many conditions if it is to really benefit the importing countries as a whole.

3 Virtual water trade also occurs in the form of food aid and *ad hoc* imports at times of drought and emergencies. As such measures are not strategic, they are not considered in the debate conducted here, since additional aspects would then have to be included.

The long list of these conditions quickly makes it clear that, if Virtual Water Trade is to be introduced at all, then never radically, but always gradually or partially and over a period of several decades. Only if such a cautious approach is adopted will there be a chance of the various conditions evolving in a country simultaneously, thus enabling social risks to be reduced and compensated for.

(a) Adequate foreign exchange revenue and social absorption capacity

Virtual Water Trade requires the adequate availability of foreign exchange, or a positive balance of payments, which a country must have to import food in the long term. Besides this, a high social absorption capacity is a decisive condition for the success of Virtual Water Trade. As a reduction in agricultural activities in the potential importing countries would make farmers and rural workers redundant in the long run, the implementation of the approach calls for alternative non-agricultural income opportunities (industrialization).

(b) Abandoning the paradigm of food sovereignty

As Virtual Water Trade presupposes that the paradigm of national food sovereignty is abandoned, it is politically sensitive. Efforts to achieve a certain degree of national independence give way to the growing acknowledgement of mutual dependence. With the advance of globalization, this process has long since been occurring in many spheres, and it is becoming increasingly difficult to explain why food should be an exception in this respect.

The fact is, however, that growing Virtual Water Trade would actually increase the dependence of the importing countries on the exporting countries and possibly leave them open to political blackmail. This is highly unpopular and one of the reasons why the countries concerned are abandoning the paradigm quietly, i. e. without any explicit statements by political decision-makers (e. g. Egypt, Jordan).

The importing countries concerned can reduce the risk of growing political dependence by widening the range of countries from which they import goods. They should also choose the most reliable trading partners they can, ones that may be prepared to give an assurance that their exports will not be affected by any political conflict situations that may arise.

(c) The alternative goods produced must be marketable

Abandoning current forms of production makes sense only if there is a market for the industrial goods manufactured as alternatives and at least as much profit can be made from them. Accordingly, market conditions must be favourable for the countries that participate in Virtual Water Trade.

Non-tariff trade barriers already represent the greatest hurdle for developing countries wanting to compete with processed or industrial products in the world market. The virtual water strategy could therefore be pursued successfully only if international trade barriers were lowered further.

(d) Good transport and infrastructure in rural areas

Good infrastructure in rural areas is similarly an essential requirement for successful Virtual Water Trade. If the distribution of imported food is not ensured and it remains in the urban areas in which it first arrives, the people may lose food security and consumer prices in rural areas may rise and so have major social consequences, such as migration into cities and associated uncontrolled urbanization.

(e) Virtual Water Trade might be accompanied by a process of centralization and lead to a growth in government power

If Virtual Water Trade was politically induced, central government would gain a monopoly over some food or food distribution, which would increase the need for good governance. In its pure form the approach opposes the decentralization efforts of many countries as well as a decentralized water policy, since Virtual Water Trade requires centrally controlled food distribution.

In general, it must therefore be ensured that the political decision-makers do not use this monopoly for strategic purposes, as is often the case with food aid, for example. That might promote corruption and clientelism. Stable institutions and good governance are therefore essential for successful Virtual Water Trade.

(f) International Virtual Water Trade is favoured by EU and US agricultural subsidies, while regional South-South trade is obstructed

Water-scarce countries able to use Virtual Water Trade with the classical industrialized nations of Europe and North America to their own benefit will support the retention of agricultural subsidies, while poor agricultural countries dependent on the export of agricultural products will be adversely affected in not only directly, but also indirectly. This will widen the gap between the interests of the very poor and the emerging developing countries. As the EU gave an assurance in Hong Kong in 2005 that it would abolish agricultural subsidies, this negative scenario may not come true.

(g) Besides ecological advantages for the water balance, ecological disadvantages can be expected

The ecological sustainability of Virtual Water Trade may be determined not only by positive effects on the water balance in the food importing countries but also by effects on the ecosystems of the food-exporting countries, where increased farming may lead to greater land use and to the pollution of soil and water by agro-chemicals. The basis of assessment used for global effects is the model of the “ecological rucksack”, which covers all ecological influences of trade flows. The angle from which Virtual Water Trade was appraised would thus be widened considerably to include the “alternative consumption” of other resources. It is important in this context to seek a balance of human and environmental interests.

(h) The concept defies economic facts and rules of the world market

Current trade in economic goods – including, therefore, agricultural products – does not take place because of water scarcity. It mainly conforms to the rules of comparative cost advantages in such factors as manpower, land, and capital, as well as the supply and demand for economic goods. Water prices thus seem to be the only means of influencing food production and flows of agricultural goods in the world market. Only when pricing gives water an economic value will it become a relevant expense factor and so have an impact on trade decisions.

4 Conclusions

Virtual Water Trade and integrated water resource management – opposites or complements?

Virtual Water Trade in the form in which it is already taking place is – as Anthony Allan puts it – economically invisible and politically silent, not only because it is inconsistent with the paradigm of self-sufficiency, but also because it enables both the political and the economic cost of mobilizing local water resources to be avoided. For political decision-makers Virtual Water Trade is thus something of a temptation and possibly a convenient way of avoiding undesirable action, since it may superficially reduce the need to take important reform measures to ensure the sustainable use of water resources.

The present study therefore advocates that both the political decision-makers and international development cooperation focus not too much on Virtual Water Trade but much more on measures to improve water management.

The Integrated Water Resource Management (IWRM) model must take centre stage in this context. It is important here first to establish what causes a country's water scarcity. Depending on whether it is a question of absolute water scarcity or whether institutional inadequacies or economic poverty are the main causes, the measures taken must be geared appropriately to overcoming the scarcity. Water shortages are often due to inadequate management or unequal allocation and in such circumstances Virtual Water Trade is as no more than an interim solution, eventually encouraging the wastage of water and possibly doing nothing to eliminate the cause of scarcity.

It therefore continues to be argued that the Virtual Water Trade strategy is suitable rather as a complement to other necessary steps in sustainable water management and tends to be harmful as a separate (trade) policy strategy. Virtual Water Trade is potentially appropriate as a support measure where it makes it unnecessary for costly and unsustainable projects to be implemented to increase the water supply. Examples of such projects are some of the dams built for irrigated agriculture or pipelines for the energy-intensive transport of water from distant areas.

The existing IWRM programs are essential for a good water policy and should be expanded and supported. As IWRM is introduced, water master plans should be drawn up at national and regional level, with Virtual Water Trade possibly included as one element. Virtual Water Trade may be justified where, for example, other resource management strategies fail.

Virtual Water Trade may be an attractive option for water-poor industrialized countries or countries well on the way to industrialization:

In view of the differing economic and institutional capacities of the countries affected by water scarcity, the view advanced here is that Virtual Water Trade is feasible and appropriate only in countries which are already well on the way to industrialization and therefore have good infrastructure and alternative, non-agricultural employment opportunities. These are, in particular, the anchor countries, but also some small newly industrializing countries.

However, even in these countries, which are generally best suited for the strategy, the concept of Virtual Water Trade is socially tolerable only if it is introduced not radically, but very cautiously and with good governance. If these conditions are not (partly) satisfied, its introduction is almost bound to result in the rural poor being placed at a disadvantage and in excessive government regulation. Furthermore, Virtual Water Trade has many cultural, ecological and social disadvantages, which are described in greater detail in the study. Virtual Water Trade is also inevitable for those countries which suffer from extreme absolute water scarcity and therefore have no other options for producing food in sufficient quantities themselves. Representatives for this category are Egypt, Israel, Yemen and Jordan.

Virtual Water Trade is neither feasible not desirable for poor, water-scarce agricultural countries among the classical developing countries:

For many reasons the group of *Least Developed Countries* (LDCs), whose people engage in subsistence farming and whose economic potential lies in the development of (labour-intensive) agriculture, can, on the other hand, derive little benefit from Virtual Water Trade even in the middle term. For one thing, the strategic import of food requires too much foreign exchange, which cannot, as a rule, be earned in sectors other than agriculture. At the same time, the distribution or marketing of imported food calls for a functioning logistical apparatus, good general governance, social absorption capacity and a good transport system. These conditions are, however, rarely met in the LDCs.

The consequences of strategic Virtual Water Trade for the people of countries at a low level of development would be highly negative. As a result, its rigorous introduction would threaten even their livelihood and independence, i. e. their social and cultural integrity. Even its partial introduction would undermine the productivity of the people and their opportunities for development, which lie primarily in the development of agriculture and its upstream and downstream sectors. In these countries, then, the goals of achieving food security and maintaining the ability to develop must be seen as having priority over measures to overcome water scarcity. Developing the agricultural sector and increasing agricultural production – by means of irrigation as well as other methods – should therefore have priority in the initial stages.

The implementation of the concept should be promoted at regional and national level and should also be achieved slowly and partially:

Currently missing from the debate on Virtual Water Trade is an integrated view that makes a distinction between global, regional and national Virtual Water Trade and, on the other hand, deliberates on the extent to which the concept should ideally be implemented and on the time horizon. Although the rigorous introduction of Virtual Water Trade is not only unrealistic but also entails absurd consequential scenarios, a thorough analysis of the requirements and consequences of any introduction is necessary. For example, introduction in limited areas, introduction related to specific crops or gradual introduction may be extremely interesting and advantageous for some countries and regions, and the emphasis should therefore be on such approaches from the outset.

The regional context and specific national problem situations must be taken into account:

In terms of regions of the world, the Virtual Water Trade strategy might be particularly advantageous for the water-scarce, middle- to high-income countries of the Middle East and North Africa. They are, for example, Egypt, Jordan, the Arabian Peninsula, Israel and possibly Algeria, but not, on the whole, Tunisia and Morocco.[4]

In this case, the exporting countries would be predominantly the industrialized, water-rich countries of the North, whose agricultural subsidies make them particularly competitive internationally (North-South trade). However, as the EU promised at the world trade conference held in Hong Kong in 2005 to abolish its agricultural subsidies by 2013, the hitherto one-sided gearing of trade to water-rich countries of the North will slowly change.

It is to be hoped that the abolition of agricultural subsidies will stimulate South-South trade, and regional trade can also be seen as a strategy for Virtual Water Trade. It is eminently suited to trade among the countries of Southern Africa, for example. As the SADC, a regional economic community, includes

4 Egypt, which is already exploiting its own water resources to the full or overusing them at the expense of other countries on the Nile, is even now importing large quantities of food and is therefore one of the few countries already strategically relying, or having to rely, on agricultural trade because of the shortage of water.

both water-rich and water-poor countries, Virtual Water Trade might benefit all concerned. The more industrialized, water-poor member countries, such as South Africa and Botswana, would import more food from their poorer, water-rich neighbours, such as Zambia.[5]

Another variant of Virtual Water Trade, which has in fact existed for some time, consists in the offsetting of water shortages through trade within countries having heterogeneously distributed water resources. This is true of many countries, examples being countries of East Africa and Latin America, but also such anchor countries as Brazil, China and India. They have more or less good infrastructure and a dynamic economy. Traditionally, such internal Virtual Water Trade has existed for many thousands of years between cattle herders and arable farmers, as in the Sahel region, for instance. How these benefit-sharing agreements might be modernized and revived, thus enabling food security to be increased for all concerned would be an interesting question in its own right.

Greater account should be taken of the economic view of the concept in the debate:

Further critical conclusions are reached when the concept of Virtual Water Trade is considered against the background of the general debate on agricultural trade and addressed from the market economy angle rather than in planning terms. The study begins by describing the determinants of agricultural trade with a view to establishing whether water scarcity is already a relevant factor in agricultural policy decision-making. The most important finding in this context is that, as a rule, the determinants of both global agricultural trade and national and local agricultural production have hitherto been different from those of water scarcity. The comparative cost advantages make it clear that in almost every case the factors of production – labour, land and capital – are decisive for agricultural trade, not water scarcity (an exception being Egypt, and, to some extent, South Africa). Owing to the absence of quantity-dependent charges for irrigation water in most countries, water has – until now – not been a cost factor, regardless of its scarcity. In the agricultural sector in particular, the European Union's subsidies and other

5 Zambia is a water rich country with enormous agricultural potential, which is hardly being tapped at present. Poor means of transport, bad governance, the general poverty of the country and the unfavorable global economic environment have, however, hitherto hampered the rapid growth of the agricultural sector.

forms of export promotion as well as international trade agreements play so large a role that any major change of circumstances in the short term is hardly a realistic prospect. This might change, however, if water prices were introduced. Then agricultural trade would also be automatically guided by the availability of water, and regulatory measures and special policies to promote Virtual Water Trade would then probably be superfluous.

A step forward would be taken if the relative pre-eminence of agricultural operating costs encouraged the growing of less water-intensive crops. However, water prices would then have to be set higher than currently expected, since the price of water can have a guiding effect on the choice of crop only if it is included in agricultural direct costing as a relevant factor along with other agricultural inputs such as seed, fertilizer and pesticides. So far, however, water charges rather than political prices acting as a signal without constituting a relevant cost factor have been discussed in the countries concerned. As there is no desire to push users into withdrawing water illegally, these charges are usually set very low.

For these political and also social reasons and as a reaction to the EU's and USA's agricultural subsidies, a water price policy guided by real costs and/or the scarcity of water will be implemented in developing countries, at best, in the longer term, since it would overly weaken their competitiveness in the agricultural sector in the short term.

It is argued here nonetheless that the debate on Virtual Water Trade should be conducted against the background of the economic valuation of water more than has been the case in the past. Where it is possible to fix prices or fees, it should be done even if the level of the prices does not reflect the scarcity of the resource. As one of several factors, water pricing would then help to increase awareness, encourage the use of water-conserving technologies and good water management and tend to lead to the growing of water-conserving crops. Even though, on the whole, these contributions alone may not bring about a fundamental change, water charges will increase not least sources of revenue for water authorities and thus their potential for regulatory action. After all, water pricing may gradually help to ensure that consumption patterns and agricultural trade develop in the required direction. Water-rich countries will then prefer to produce, consume and export water-intensive crops, leaving water-poor countries to concentrate on growing more drought-resistant crops. This trend would be rational in every respect, in terms of integrated water resource management, and would also remove the initial image of Virtual Water Trade as a tool of a planned economy.

For development cooperation the emphasis should be on promoting efforts to make the strategy – where appropriate – a constituent of the general water policy environment:

A question that arises is whether and, if so, how Virtual Water Trade can be supported where it appears appropriate and is sought by the countries concerned. The first step would be to ensure a sound legal basis, general measures to promote a good water policy and good governance or even infrastructure measures, into which Virtual Water Trade can then be, as it were, integrated as a strategy.

Options for direct action also exist in the study of the consequences and the identification of indicators as the most reliable political decision guidance. A contribution might also be made to the collection of data that enable figures to be put to indicators and provide pointers to promising strategies. Development cooperation could assist by giving advice on the institutionalization of the approach and contribute to increasing awareness and to the public debate. The overriding objective here is to ensure that Virtual Water Trade – where appropriate – becomes a firm part of Integrated Water Resource Management.

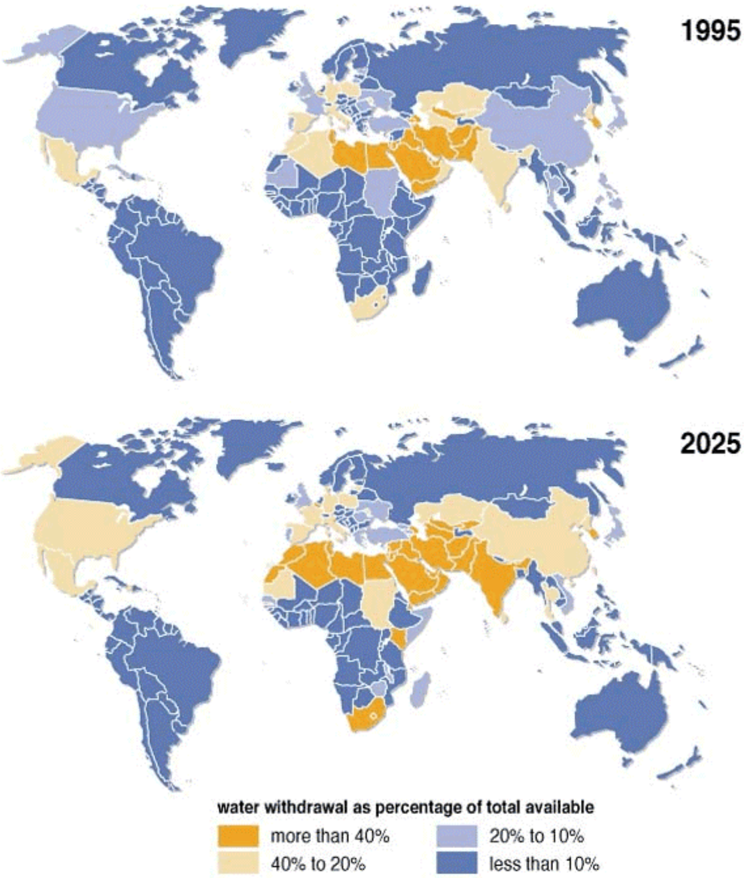
1 Introduction

The concept of Virtual Water Trade is based on the idea that water-poor countries are increasingly meeting their food requirements by importing crops from water-rich countries. The aim in this context is to ensure that the water resources thus saved are used in more productive areas, possibly even within agriculture, but rather in the industrial sector, where more value added is generated per volume unit of water. As agricultural production in most developing countries accounts for the largest proportion of water consumed (some 70 %, up to 90 % in arid and semi-arid countries), the potential for (national) savings and the windows of opportunity opened if this strategy was implemented consistently would be enormous.

The debate is first divided over the fundamental question whether such a strategy can in fact be formulated, since it is doubtful, primarily from an economic viewpoint, that the availability of water is or can become an important determinant of (agricultural) trade in a medium term perspective. This question is posed mainly by economists, who have only recently joined in the debate on Virtual Water Trade. As, in many cases, water prices either do not exist at all or are set so low that they in no way reflect the scarcity of water, the factors of production – labour, land and capital – continue to determine the orientation of production. Where water has no value, it cannot be regarded as a limiting factor. If, on the other hand, an economically appropriate value was attached to water or to its supply, it would automatically become a valuable factor of production in water-poor countries. There would be no need to implement the Virtual Water Trade strategy under a special promoting policy, since trade would regulate itself in accordance with comparative cost advantages.

The second line of argument concerns the question of the formulation of an appropriate political control strategy. This discussion is based on the fact that even countries whose water resources are becoming increasingly scarce and polluted do not charge economically appropriate prices. There are various reasons for this: inadequate institutions and the unpopularity of such a decision, for example. In the final analysis, the absence of water prices acts as an indirect subsidy to agriculture and makes the countries concerned somewhat more competitive, which are able to subsidize their agricultural sectors directly. Although, in the given circumstances,

Figure 1: Water withdrawal as percentage of total available



Source: http://www.unep.org/geo2000/english/0046.htm charging no or low water prices is an understandable political strategy, it leads to the total exploitation of water resources and is therefore a fatal error in the longer term.

This study summarizes current contributions to the debate and makes its own contribution by undertaking a comprehensive analysis. It reveals the positive and negative influences that may be associated with the introduction of Virtual Water Trade as a political strategy, especially influences on society, the framing of policy, the economy and the environment, which are described in the following chapters. On this basis, the study identifies requirements which should be met and measures which should be taken while or before Virtual Water Trade is introduced in order to minimize the negative implications.

Initial indicators are also given to enable potential beneficiaries of strategic Virtual Water Trade to be identified. As will be shown, for a conclusive assessment of its positive and negative effects – at national and regional level – a regionalized view or examination of individual cases is needed. In this respect, no more than general recommendations for the possible involvement of international or bilateral development cooperation in Virtual Water Trade are presented.

2 Methodological approach

This study is essentially based on three components: the appraisal of available literature on the subject of "Virtual Water Trade", the analysis of ten statements on specific aspects by experts in various disciplines and the evaluation of the discussions at two expert forums held at the DIE on this subject.

The relevant literature includes above all the publications of Anthony Allan of the *School of Oriental and African Studies* (SOAS), to whom the concept of Virtual Water Trade can be largely attributed.[6] Allan is primarily concerned with the social impacts of Virtual Water Trade on the countries of the Middle East and thus its qualitative implications for them. A more global and more quantitative approach to the concept is adopted in the publications of Arjen Hoekstra (UNESCO-IHE, Delft), which were

6 See Allan (1996; 2002; 2003a; 2003b).

compiled in connection with the *International Expert Meeting on Virtual Water Trade* held on 12 and 13 December 2002.[7] The *Proceedings* also cover regional cases in Africa, the Middle East and Asia. The analysis of this and other literature culminated in the formulation of practical questions relating to the establishment of statements, for the discussion of which an interdisciplinary kick-off workshop was held at the German Development Institute on 6 September 2005. The debate was attended by thirteen academics who are regarded as experts in the field of Virtual Water Trade or who were able to contribute to the assessment of consequences because of their expertise in fields associated with Virtual Water Trade.

On the basis of these preliminary discussions ten international academics from Germany, South Africa, Austria and Jordan were commissioned to draw up expert statements. Together with the analyzed literature, they form the basis of the present study. They cover both hypothetical thoughts on the potential and risks associated with increased Virtual Water Trade and practical progress reports from countries, such as South Africa, which are cautiously introducing the strategy in policies or legislation.

A meeting with Anthony Allan at the SOAS in London on 30 September 2005 enabled a number of questions and problems relating to the possible political implementation of the strategy to be discussed bilaterally. What was learnt at this meeting has also had an influence on the study.

At a second workshop, similarly held at the DIE on 7 December 2005, the expert statements were presented and discussed on a larger scale. The workshop was attended by 26 professionals from various research institutes and development organizations. Three working groups also considered questions concerning (1) opportunities for and limits to the implementation of the strategy at political and legislative level, (2) the social, ecological and economic conditions to be satisfied by a country if it is to benefit from Virtual Water Trade and (3) the risks which may be associated with any expansion of or strategic orientation towards Virtual Water Trade, such as the risk of sustainable water resource management being neglected at national level.

7 See Hoekstra (2003).

The aim of the study is, then, to present as comprehensive a picture as possible of the concept itself, the most important issues discussed and the potential of and risks associated with the concept, as seen by all relevant disciplines. The latter include not only ecology and agricultural science but also politics, economics and the social and cultural sciences.

This study sets out to provide the BMZ both with a summary of the most important lines of the current debate and with an assessment by the authors of the potential and risks associated with the concept of strategic Virtual Water Trade and so to enable the BMZ to adopt and defend its own position in that debate.

3 The concept of Virtual Water Trade

3.1 Virtual Water Trade as an analytical instrument and a political strategy

The production of almost any good requires a certain amount of water. In the case of industrial goods it usually takes the form of cooling or washing water, while in agricultural production water (rain, ground and surface water) is needed to enable plants to grow and animals to be fed and watered. Such water is known as "virtual water" because, though used for production, it is no longer contained as such in the product or only in very small quantities. When the goods produced – in this case, such agricultural products as cereals, fruit and vegetables – are traded, Virtual Water Trade is said to occur.

The term "virtual water" was introduced by Anthony Allan in the early 1990s, but did not attract international attention among experts until some ten years later. In December 2002 the first international conference on the subject was held in the Dutch city of Delft, and since then the media have also used the term whenever the discussion has turned to the protection and conservation of global and national water resources.[8]

The intention that trade in agricultural products, and thus in virtual water, will enable water resources to be "conserved" at global level firstly sounds attractive. This results from the variation – very significant in some cases

8 See Hoekstra (2003).

– in the efficiency with which water is used by plants in different countries. In France, for example, 530 litres of water are needed to produce one kilogram of maize in irrigated farming, as against 1,100 litres in Egypt. These differences occur basically because of the higher evapotranspiration rates in hot, arid and semi-arid regions compared to cooler regions with. The saving from a global viewpoint thus amounts to 570 litres of water per kilogram if France grows maize and Egypt imports it rather than growing it itself.[9] Globally, agricultural trade is already resulting in the "saving" of some 455 km^3 of water each year, which is equivalent to about 8 % of water resources compared to local consumption. It thus appears that the potential savings if strategic Virtual Water Trade is introduced consistently are enormous, since the more products produced in use-efficient countries, the more water "saved" globally.[10]

What is overlooked in the debate, however, is that, owing to the cycle in which the Earth's water is involved, it cannot be conserved at global level. The only effect that may be globally relevant is the longer time elapsing before water is reused. Globally, this may lead to less pollution of water by agro-chemicals and salts. The same effects could, however, be achieved with other, possibly more appropriate strategies.

Hoekstra, on the other hand, did not originally consider Virtual Water Trade with a view to propagating it as a political strategy to be implemented in order to save water, but used the concept merely as an analytical instrument to measure global material flows occurring as a result of trade in agricultural products. It is therefore only when the subject is considered from the angle of political science that the idea of using the possible savings effects to the benefit of water-scarce countries and, on that basis, contemplating political strategies is born.

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9 See Renault (2003).

10 The debate on efficient water use and the savings effects actually associated with it is not, however, pursued here, since even within agriculture water is not really consumed, but remains in the water cycle and so can be used again at a time x and a place y. Given this fact, the goal of the global conservation of water therefore appears generally questionable, all the more so when it is realized that the scarcity of water always manifests itself locally, never globally, and it is therefore appropriate that water conservation should be geared to countries which actually suffer from water scarcity.

In this study Virtual Water Trade is discussed as a political concept of this kind. Its introduction would mean political decision-makers actively pressing for the increased import of agricultural products in order to conserve water resources at national level. According to Allan, the concept is suitable as the basis of a political strategy, since *"serious local water shortages can be very effectively ameliorated by global economic processes"*.[11] However, this calls for the formulation of appropriate laws, rules and measures to encourage Virtual Water Trade. The transformation of the concept into a practical policy presupposes an appropriate environment for restricting the production of water-intensive (i. e. mainly agricultural) goods in water-scarce countries and promoting the import of such goods. Conversely, water-rich countries would have to increase the export of water-intensive products to water-scarce countries. The water resources thus saved or released in water-scarce countries could then be more efficiently used in industry.[12]

3.2 Virtual Water Trade in the debate on globalization and agricultural trade

3.2.1 Globalization and growing Virtual Water Trade

With the advance of globalization, worldwide trade in general and Virtual Water Trade are growing. The international exchange of goods of all kinds entails the transport of large quantities of virtual water over ever greater distances. Agricultural products take the largest share in this respect, accounting for some 80 % of virtually traded water.[13] The concept of strategic Virtual Water Trade is based on the idea that these existing trade flows should be so used or guided that water-intensive goods are increasingly exported from water-rich to water-scarce countries and global water resources are thus used and indirectly distributed in the most efficient way possible. Accordingly, agricultural products should be increasingly produced in countries and regions where water is an abundant resource.

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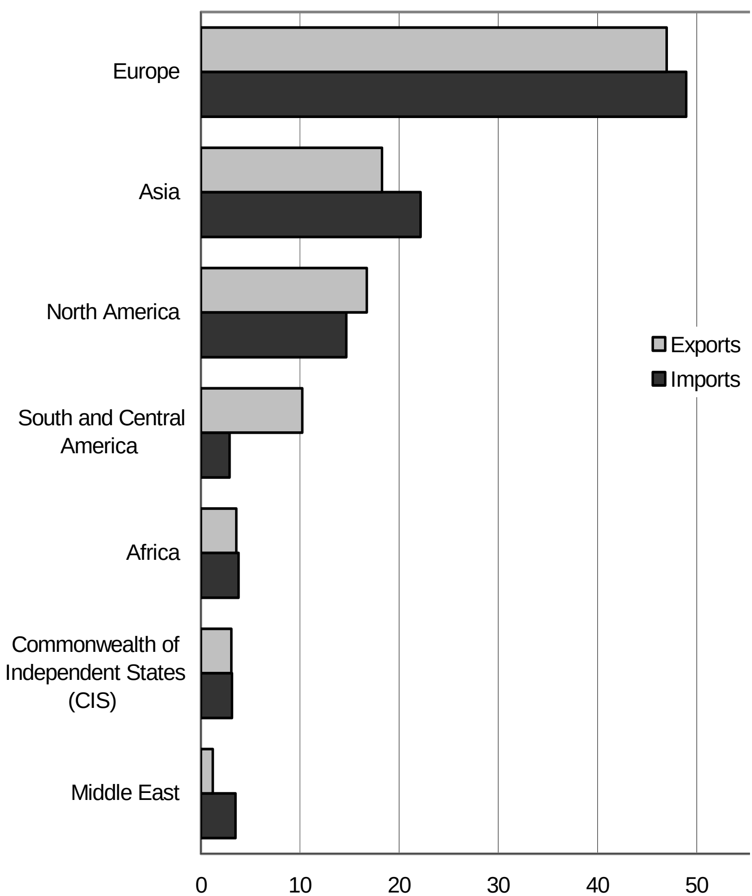
11 Allan et al. (2003).

12 This is true only of freshwater, i. e. "blue" water resources; see Chapter 5.1.1.

13 See Chapagain / Hoekstra (2005).

Figure 2: Regional shares in world trade in agricultural products, 2004 (percentage)



Quelle: WTO (2005b)

As Brüntrup shows in his statement, some 3,854 km^3 of water (including irrigation water) was used in 1995 in the global production of cereals for export. In the case of only 2 % of this quantity, i. e. about 79 km^3, did a shortage of water in the country concerned play a part as a determinant of trade.[14]

Global exports of agricultural products have risen since 1990 from some US$ 415bn to about US$ 783bn,[15] i. e. the trade in agricultural products – and thus in virtual water – has more than doubled when the fall in world market prices since 1990 is taken into account. The region with the largest volume of trade in agricultural products is the European Union (EU), which is both the leading exporter and the leading importer, and two thirds of that trade takes place within the EU itself.[16] The EU aside, Asia and North America account for the largest proportion of global trade in agricultural products, Central and South America being the largest exporters (see Fig. 2). The water-scarce countries and regions, i. e. North Africa, parts of Southern Africa and the Middle East, play a subordinate role in global trade in agricultural products, but many are already net importers of food. Hoekstra and Hung have calculated that the countries of both the Middle East and Africa import most virtual water from North America, Western Europe and Asia.[17]

The debate on Virtual Water Trade thus forms part of the general debate on problems and opportunities presented by increasing globalization and so also on the current WTO negotiations and agreements concluded. The question that arises, after all, is how far water-scarce developing countries can influence the nature and quantities of agricultural products involved in strategic Virtual Water Trade. Much of agricultural trade is determined by the OECD, newly industrializing and anchor countries.[18] The developing

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14 See Brüntrup (2005).

15 See WTO (2005b).

16 See WTO (2005a).

17 See Hoekstra / Hung (2003).

18 The term "anchor country" was introduced through a study published at the German Development Institute (see Stamm 2004). It describes a new category of countries which are big in terms of area and population and which are at the same time economically dynamic and politically relatively stable. They are often characterized by huge poor areas but also by industrial growing centres. It is assumed that anchor countries have a big impact or radiation effect on the development of their neighbouring countries which can turn out positively (as in the case of South Africa, for example) or negatively (Nigeria, for example). As far as their water resources are concerned there are very water rich countries (e. g. Brazil, Turkey) as well as (potentially) water scarce countries (as

countries, including, then, the water-scarce among them, have, of course, little influence on developments in the world market.

In these circumstances it is interesting to determine how flows of trade in agricultural products can best be exploited, what dependencies exist in the structure of world trade and which can be influenced to make for the more effective and efficient use of global water resources. Of importance in this respect are the agricultural or export subsidies paid primarily by the European Union and the USA, which are believed to distort the market, particularly by countries exporting agricultural products, and hamper their access to the world market. What is important for water-scarce developing countries wanting to acquire more food in the world market or from water-rich countries is, however, that these products should be as cheap as possible. The views of the developing countries on agricultural subsidies are naturally divided, both among and within these countries, depending on whether they see themselves as consumers or producers of food, the consequences differing accordingly. The BMZ comments:

> *"On the question of the abolition of export subsidies the developing countries are less united in their views. On the one hand, there are frequent complaints about disturbances of the market due to subsidized EU exports; on the other hand, the developing countries that are dependent on food imports (especially cereals) are well aware that in the short term they derive revenue gains from the present situation [...]."*[19]

At the world trade conference held in Hong Kong in December 2005 it was decided that export subsidies should be abolished by 2013. It will therefore be more expensive for water-scarce countries to import food, which will be a major obstacle to the expansion of Virtual Water Trade. However, it may strengthen South-South trade, possibly the politically, socially and ecologically preferable variant of Virtual Water Trade, as will be explained in the course of the study (see also Chapter 6.2).

South Africa or China) amongst the 15 anchor countries. Most of these countries embrace several climate zones and thus water rich and water scarce areas. For this reason and because of their mostly sound infrastructure these countries have the chance to mitigate or to solve their water problems by using inner-state supply mechanisms.

19 http://www.bmz.de/de/service/infothek/fach/spezial/spezial043/spezial043_17.html, 17 January 2006.

3.2.2 Determinants of agricultural trade and the production of agricultural products

As Chapagain and Hoekstra have calculated, an annual average of 987 km^3 of virtual water was traded between 1997 and 2001 in the form of agricultural products.[20] This is equivalent to 61 % of total Virtual Water Trade; a further 17 % was traded in the form of animal products and 22 % in the form of industrial goods. Of the total global consumption of water in agriculture, 15 % was used to produce exports. Brüntrup comments:

> *"Even from an initial rough analysis of the leading importing and exporting regions it is clear, however, that agricultural trade does not necessarily follow the relative availability of water. Water availability is extensive in Japan and Europe, yet they import huge quantities of agricultural products, especially tropical products and animal feed, but many other products besides. As a rule, a country both imports and exports agricultural products, in many cases even within the same category (e. g. vegetable oils). Most sub-Saharan African countries, especially the poorest, have become net importers in recent decades, regardless of whether they are located in the arid or the humid tropics. The determinants of international agricultural trade are many and varied."*[21]

Most of global water consumption in agriculture is intended for national consumption. As, traditionally, the food available locally determines food patterns and thus the demand for products, demand can largely be met in local markets. Ideally, only the quantity that cannot be produced locally and non-local products are purchased in other markets or in the world market.[22] In principle, import and export relationships occur because of different production conditions encountered by countries and producers, which result in different levels of productivity of the factors of production – labour, land and capital.

"The reasons for the differences in productivity remain open. According to an extension of the principle of comparative cost advantages (Heckscher-Ohlin theory), a country concentrates on the products for whose produc-

20 See Chapagain / Hoekstra (2004).

21 Brüntrup (2005, 2).

22 This is a simplified description, which takes no account of problems due to subsidized food or food aid supplies.

tion it can use factors of production of which it has, compared to other countries, a surplus, since they will be – comparatively – cheaper. In the case of developing countries those factors are typically unskilled labour and (in many, but not all situations) land."[23]

Brüntrup demonstrates in his statement that water has hitherto influenced the productivity of the other factors of production only as an indirect factor, where, for example, the productivity of land declines because of inadequate rainfall. In irrigated farming in particular, water can become a factor of production in its own right only if (a) it has to be paid for or (b) "subsidized water is provided only when the economic costs of alternative uses are charged for."[24] Economic opportunity costs may also arise where the installation and maintenance of irrigation infrastructure have to be paid for or where, in accordance with the "polluter pays" principle, farmers who pollute water resources are required to share the cost of the clean-up.

Another determinant of agricultural trade and the growing of certain agricultural products is the path dependence of production. This means that a form of production that has evolved over time is difficult to revise, since factors of production, production technologies, accumulated know-how and local institutions are in most cases inflexible. Where a decision on a growing pattern, an applied technology, etc. has been taken and accepted in the past, all further developments, such as local institutions, are based on that decision. In other words, subsequent generations adopt the technological standards, knowledge on the use of inputs and institutional arrangements and retain them even when they might be replaced with more efficient ones. One reason for this is that innovations are usually associated with very high costs, another that institutional arrangements in particular are often felt to be a tradition, and the will or courage to change them is therefore frequently lacking.

23 Brüntrup (2005, 3).

24 Brüntrup (2005, 5).

3.3 Virtual Water Trade at global, regional and national level

3.3.1 Global Virtual Water Trade

Any form of agricultural trade – whether global, regional or national / local – can be designated Virtual Water Trade. The world market, and thus almost all global agricultural trade flows, represents the platform for by far the largest proportion of traded virtual water. Brüntrup argues, however, that a negligible proportion of this trade occurs because of a country's water shortage and that comparative cost advantages, e. g. favourable labour costs, determine trade (see Chapter 3.2). As water can normally be used free of charge at present and in most countries is not yet so scarce that it can no longer be used, Virtual Water Trade has so far attracted little attention globally as a trade policy strategy.

The strategy of Virtual Water Trade is therefore pursued only by countries where scarcity is well advanced and sufficient foreign exchange is available. Malzbender describes two options in his statement: (1) a water-scarce country adapts the strategy and imports virtual water to compensate for its own inadequate water resources. This is true of Egypt, for example, a net food importer. Nor are its neighbours capable of supplying it with sufficient food. It therefore looks to the world market or its largest food exporters, such as the USA and Canada. The strategy could, however, also be applied (2) within an (economic) region.[25] But in both cases the determinant of Virtual Water Trade is not cost advantages, but absolute water scarcity.[26]

3.3.2 Regional Virtual Water Trade

In his statement Malzbender identifies the SADC region as being potentially capable of applying the concept of Virtual Water Trade strategically:

> *"Some relatively water-rich countries in the SADC region, namely Angola, DRC, Mozambique and Zambia are well suited to grain pro-*

25 See Malzbender (2005).

26 There is also the possibility of virtual water trade within individual countries, a possibility which will be considered in the next section.

> *duction […]. At the same time, the countries in the south-west of SADC, namely Botswana, Namibia and South Africa all experience some level of water stress and are in the process of adapting policies to use water more efficiently."*[27]

Malzbender refers to two premises for Virtual Water Trade at regional level, which he does not believe are currently satisfied in the SADC region: a full understanding of the strategy and the political will to implement it.

> *"At the current level of development in the potential net food exporting SADC states, Angola, DRC, Mozambique and Zambia, the regional implementation of the virtual water strategy remains theoretical. All four countries are currently net food importers and some of them have in fact in the recent past been recipients of large amounts of food aid […]. Ironically, the largest cereal exporter in the SADC region is the water scarce South Africa, which exports large amounts of maize into neighbouring countries."*[28]

Besides the SADC region, however, it would be theoretically possible to conceive of other groups of countries which might develop within regional economic communities or indeed establish new regional strategies, examples being ACP states in Africa and Mercosur countries in Latin America, each group including both water-scarce and water-rich countries.

3.3.3 National Virtual Water Trade

In countries having heterogeneous climatic and natural areas virtual water can also be traded nationally or locally. As China, for example, will face serious water stress in the future,[29] it would undoubtedly do well to establish a (further) national strategy to tap fully the potential for water conservation by means of Virtual Water Trade within its own borders. Taking full advantage of the concept of national Virtual Water Trade would be a good idea for any country having this heterogeneous distribution of water resources. Many countries are candidates in this respect: besides all the anchor countries, e. g. the countries of East Africa seem suitable.

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27 Malzbender (2005, 5).

28 Malzbender (2005, 5).

29 See Neue Zürcher Zeitung, 1 February 2006, p. 5.

In fact national Virtual Water Trade is not a new idea; it is a traditional feature in many countries, e. g. the Sahel. There it is linked with a traditional feature of relations between different socio-professional population groups: initially, the herders' cattle are very efficient at collecting what little water there is in drought-stricken regions as they migrate and, through their growth, give it a value. The cattle can then be exchanged for cereals grown by arable farmers in regions where rainfall is higher. Such benefit-sharing models are currently collapsing and being eclipsed by other factors. The recent famine in Kenya in 2006, in which people in dry areas starved, while people in more favoured regions had a surplus of food and left it to rot, shows how important intact formal and informal distribution, infrastructure and marketing systems within countries are if agricultural potential is to be tapped and survival ensured.

The advantage of a national strategy would be that it would not give rise to any new international dependencies and valuable foreign exchange would not have to be spent on food. In addition, the social, socio-economic and ecological effects of increased national Virtual Water Trade would be far more positive, since it would strengthen the country's own rural population. While more would be invested in agricultural production in agro-ecologically suitable areas, an attempt could be made in more arid areas to strengthen sectors other than agriculture. It would be worthwhile analyzing in another study how the mechanisms of national Virtual Water Trade might be appropriately modernized and revived.

4 Water savings through Virtual Water Trade

The following describes expected positive effects of Virtual Water Trade, which focus on potential water savings at global, regional and national levels. A distinction needs to be made here between water savings which can already be quantified, i. e. without any strategic exploitation of agricultural trade, and water savings likely to occur in the event of the strategic implementation of the concept. Besides the positive effect of water conservation, an indirect positive consequence of Virtual Water Trade might be some economic strengthening of the country concerned.

The following begins by describing the possibilities and difficulties encountered in quantifying and determining the value of virtual water.

4.1 Quantification and valuation of virtual water[30]

4.1.1 The virtual water content of a product

There are in principle two ways of quantifying the virtual water content of a product. On the one hand, the quantity of water actually used in the production of a good in the exporting country can be measured. On the other hand, the quantity which would hypothetically have been used if the importing country had produced the good can be calculated. The difference between these two quantities is the quantity of water saved from a global point of view.[31] In this way Oki et al. have calculated that worldwide some 455 km^3 of water is saved every year as a result of the global trade in food.[32]

In the calculation of the water savings that are possible in real terms the data collected by the UNESCO-IHE researchers lay one of the first foundation stones. Hoekstra points out, however, that there is still no generally accepted procedure for putting a precise figure to a product's virtual water content and so accurately quantifying total Virtual Water Trade. One of the difficulties is that the quantity of virtual water differs with the place and time at which it is measured. Depending on the purpose of the research, it may be appropriate to calculate standard or average values for products in order to depict, for example, global flows. For a study of the potential of Virtual Water Trade at local or national level, however, it may be necessary to calculate precise values regardless of location or season.

4.1.1.1 Calculation options

For the calculation of the virtual water content of a product the first, simple formula is water requirement (m^3/ha) divided by yield (t/ha).

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30 The following chapter is essentially based on the work of Arjen Hoekstra and his colleagues at the UNESCO-IHE *Institute for Water Education,* whose research has made a decisive contribution to the study of the quantitative potential of the virtual water trade strategy.

31 As the exporting country does not always produce with greater water efficiency than the importing country, the result may be negative in some cases, i. e. water is not saved, but consumed.

32 See Oki et al. (2003).

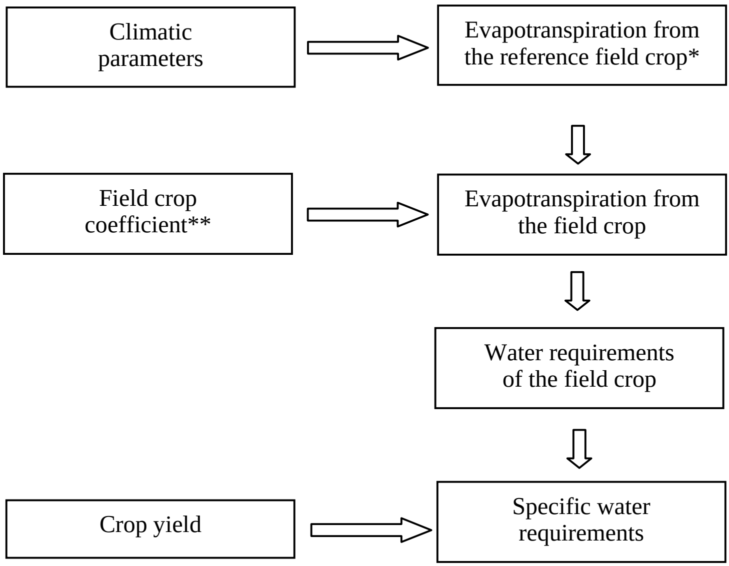
Hoekstra notes, however, that the virtual water content of a product depends on various factors, which make accurate calculation extremely difficult.[33] He refers to four factors which should at least have an influence in a precise quantification: (1) place and time of production. The quantity of water required differs with the climatic conditions under which an agricultural product is grown. Climate itself varies not only geographically, but also seasonally, and may differ from one year to another. (2) The point at which the measurement is taken. In the case of irrigated agriculture, for example, it is relevant whether water consumption is measured at the time of withdrawal or in the field itself. If the measurement is taken in the field itself, the water released by evapotranspiration must be added. (3) The production method and, with it, the efficiency of water use. Associated with this is, for example, the question of water losses due to poor infrastructure or inefficient irrigation methods. (4) The method by which water supply and consumption are added to the virtual water content of the end product where there are, for example, intermediate products. This is true of processed agricultural products and other goods. In tobacco production, for instance, the water requirements of the tobacco plant can be measured and the requirements of the tree needed as firewood for the drying process added.

Another aspect that casts doubt on the concept of conserving water, especially at global level, but also at micro level, i. e. the level of the individual irrigation unit, is the fact that run-off and drainage water can in principle be reused after being used for agricultural purposes, since not all of that water disappears into more or less closed sinks or evaporates: some flows below the point of use back into the waterway and can therefore be reused by someone downstream, for example.

At global level in particular this makes the concept as a whole very questionable, since, when a global view is taken, the evaporated water can similarly be calculated as reusable in principle when it occurs elsewhere as rainfall. Seen from this angle, global water conservation is not really possible at all.

33 See Hoekstra (2003).

Figure 3: General model for the calculation of specific water requirements



* Degree of evapotranspiration on a sufficiently damp reference surface. The only influential factors are climatic parameters.

** Calculated field-crop-specific evapotranspiration values. For detailed calculations of the various factors see http://www.fao.org/docrep/X0490E/x0490e00.htm.

Source: Hoekstra (2003), abridged

4.1.1.2 A product's specific water requirements

On the basis of statistics of the *United Nations Food and Agricultural Organization* (FAO) Hoekstra has drawn the following diagram, which can be used to calculate the specific water requirements of an agricultural product:

As we can see, Hoekstra does not take account of the fact that the water can in principle be reused and regards evaporated water as lost or consumed water.

4.1.2 The water footprint

By analogy with the ecological footprint, UNESCO-IHE has developed the concept of the water footprint to illustrate the anthropogenic influence on global water resources. The ecological footprint, which was designed by the Canadians Wackernagel and Rees,[34] is used to measure the influence of man or his consumption on the ecosystem.

> *"A nation's ecological footprint corresponds to the aggregate land and water area in various ecosystem categories that is appropriated (or claimed) by that nation to produce all the resources it consumes, and to absorb all the waste it generates on a continuous basis, using prevailing technology."*[35]

To determine the ecological footprint, a calculation is made to establish how many hectares of cultivable, agriculturally or ecologically usable land is needed to supply a given number of individuals constantly with energy, food, water, construction materials, etc. in accordance with their consumption habits. This model serves primarily to generate awareness of the anthropogenic influence of each individual or nation on the ecosystem and to impart ideas on sustainable ecological development. According to the study entitled *Ecological Footprints of Nations* by Venetoulis, Chazan and Gaudet, published in 2004, the ecological footprint of the USA, for example, is 9.57 ha per capita, whereas a Bangladeshi needs only 0.5 ha to meet his daily resource needs.

Global trade in goods results in individuals or nations not only consuming their own natural resources but also influencing the ecosystems of other countries. Partzsch and Schepelmann demonstrate this, for example, with the aid of the "area rucksack", which indicates the area which is "virtually" traded as a result of European foreign trade in agricultural products, for example.[36] They establish that the area of arable land per capita is decreasing primarily in the poorest regions of the world as a consequence of the rise in the world population, while the area used in the European Union is constantly increasing:

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34 See Wackernagel / Rees (1996).

35 See http://www.ecouncil.ac.cr/rio/focus/report/english/footprint/introduction.htm.

36 See Partzsch / Schepelmann (2005).

> *"Rather than a 'virtual' area being exported by the EU15 to regions with less land, the share of 'virtual' area tied to imports is increasing. The area used per capita in the EU15 already exceeds the global area used per capita by 72 % and continues to increase – to the disadvantage of the area used in third countries (Bringezu / Steger 2005)."*[37]

The water footprint also includes water resources which have been used in other parts of the world and so quantifies the consumption of virtual water per country or individual. It is equivalent to a country's (or individual's) total water consumption minus virtual water exports plus virtual water imports. The equation is as follows:

Water footprint = water consumption + net imports of virtual water[38]

Like the ecological footprint, the water footprint is intended to reveal the quantity of water resources which a nation or an individual consumes daily and thus how much virtual water is contained in the goods consumed. This can also show, for example, the potential for possible savings that can be actively tapped. The aim is to put the water thus saved to more effective and efficient uses.

4.2 Water savings at global, regional and national level

4.2.1 Water savings at global level

According to calculations by Oki et al., the virtual water content of all internationally traded food amounted to about 683 km^3 in 2000, while the importing countries themselves would have needed 1,138 km^3 for the production of the same amount of food.[39] The quantity of water thus saved, 455 km^3, is equivalent to about 8 % of all water used to produce food. Such critical authors as de Fraiture et al. of the *International Water Management Institute* (IWMI) take the view that this is so marginal a proportion that it is risky to pin great hopes on the strategy of Virtual Water Trade:

37 Partzsch / Schepelmann (2005, 7).

38 For a more detailed examination see Chapagain / Hoekstra (2004).

39 See Oki et al. (2003).

> *"Although the potential of trade to reduce water use may seem large – on paper – one should be careful when concluding that trade plays – or will play – an important role in global water scarcity mitigation."*[40]

De Fraiture et al. show in their study that, even in global terms, trade in virtual water may lead to the "loss" of water resources where the importer produces with greater water efficiency. In 1995, for example, Indonesia imported 2.3 m tons of grain from India. While India needed 17.4 km^3 of water to produce that grain, Indonesia would have used only 16.7 km^3. The global loss can therefore be put at 0.7 km^3. Another example reveals the losses due to different growing methods: in the same year Sudan imported grain from South Africa and Russia among other countries and so caused a global loss of irrigation water of 0.2 km^3, since it would itself have produced that grain in rain-fed agriculture, whereas the exporters used some irrigation. In much the same way as Brüntrup in his statement, de Fraiture et al. come to the conclusion that reducing global water consumption is in most cases, if anything, no more than an "unintended by-product" of agricultural trade:

> *"Water scarcity plays a minor role in shaping cereal trade flows, except for a few extremely water-short countries."*[41]

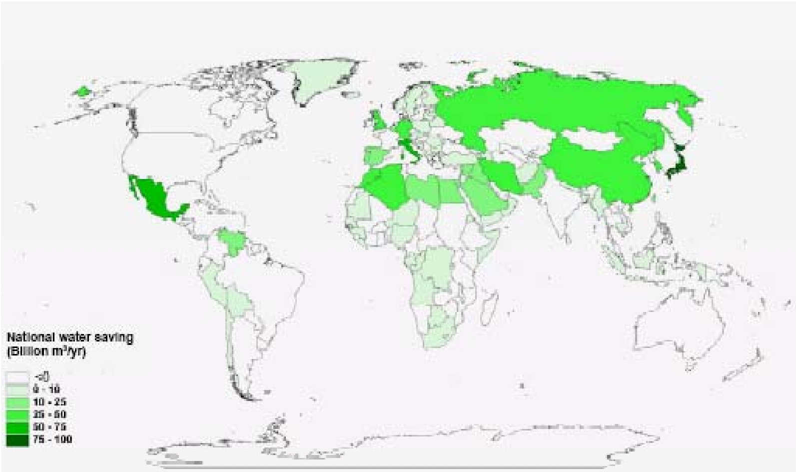
Nonetheless, it can be said, on the one hand, that even this unintended by-product cannot *per se* be denied positive effects on the water balance. Whether or not these savings are induced therefore seems irrelevant.

On the other hand, a general question that can again be raised is how appropriate it is to take a global view of water-saving options, since the global water cycle is quantitatively constant and hitherto there has been no such problem as global water scarcity, nor will there be one in the medium term. The point of global water conservation has barely been discussed among Virtual Water Trade experts, but that debate appears to be urgently needed if clarity on this issue is to be achieved. The authors of the present study believe it to be important to conserve water only where it is particularly scarce and, where at all possible, to withdraw it where it is available in sufficient quantities. If physical transport is not possible or appropriate, strategic Virtual Water Trade may be a solution, not the least advantage

40 de Fraiture et al. (2004, v).

41 de Fraiture et al. (2004, 16).

Figure 4: National water savings due to international agricultural trade (1997-2001)



Source: Chapagain / Hoekstra (2004)

being that, compared to the direct transport of water, it may save transport and energy costs.

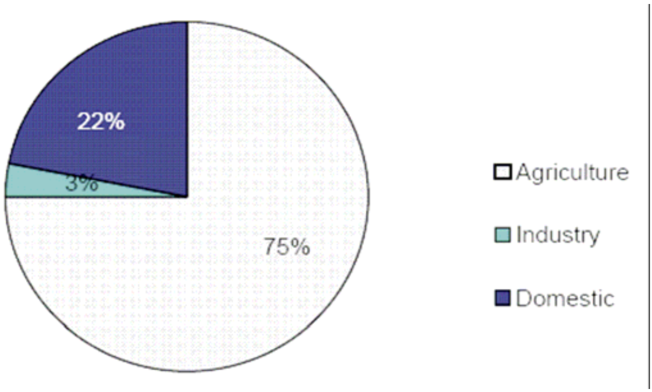
4.2.2 Water savings at regional and national level

Savings due to Virtual Water Trade may be considerable for certain countries and regions and capable of being increased further. This is true primarily of the countries of the Middle East and North Africa, Russia, Central and East Asia and parts of Central and South America (see Fig. 4).

Chapagain and Hoekstra show how much water is already being saved, or how much less is being used, at national level as a result of Virtual Water Trade.[42] Jordan, for example, uses 1.45 km^3 of its water resources each year in the production of food for domestic consumption. In the same period about three times as much virtual water, 4.37 km^3, is imported in

42 See Chapagain / Hoekstra (2004).

Figure 5: Withdrawals of surface water per sector, Jordan, 1993



Source: http://earthtrends.wri.org/pdf_library/country_profiles/wat_cou_400.pdf

the form of agricultural products. Despite this, the total annual national withdrawal of water amounts to about 150 % of renewable water resources, since the latter amount to only 1 km^3. From Figure 5 it is clear that enormous quantities of water could be saved on a national and regional level through a reduction in agricultural production accompanied by strategic Virtual Water Trade.

South Africa, which is similarly water-scarce, having a water supply per capita and per annum of a little over 1000 m^3, could also save further water resources through strategic Virtual Water Trade. Water withdrawals account for about 32.3 % of total renewable water resources, and more than a fifth of this is exported in agricultural products in the form of virtual water. Approximately the same quantity is reintroduced through agricultural imports, but strategic Virtual Water Trade could nonetheless shift the trend more clearly towards South Africa's becoming a net importer of virtual water.

Saving by means of national Virtual Water Trade may also be relevant for some countries, such as China, according to Hoekstra and Hung.[43] In this case, strategic trade between the relatively water-rich South and the dry North is conceivable. The data relating to such national or local savings potential are not, however, adequate or informative.[44] Relatively clear statements are possible only in arid countries all of whose farming is irrigated, since rainwater must then be omitted from the calculation. De Fraiture et al. demonstrate, for example, that in 1995 Egypt saved some 9.9 km^3 of irrigation water by importing grain.[45]

5 Expected positive effects of Virtual Water Trade

5.1 More efficient and effective use of saved water

To determine what alternative use is the most efficient option for the water saved by means of Virtual Water Trade, the various possible uses must be given a monetary value irrespective of sector. This is not an easy project, but it can be addressed in different ways, which are described in the following.

5.1.1 Difference between "green" and "blue" water resources

For the calculation of the water footprint and in the debate on how much water can actually be saved and what alternative uses are conceivable for that water, the distinction between "green" and "blue" water resources first made by Falkenmark seems appropriate.[46] The freshwater in aquifers, lakes and rivers is referred to as "blue", while "green" water is bound in the soil and plants and released by evapotranspiration (see Fig. 6).

43 See Hoekstra / Hung (2003).

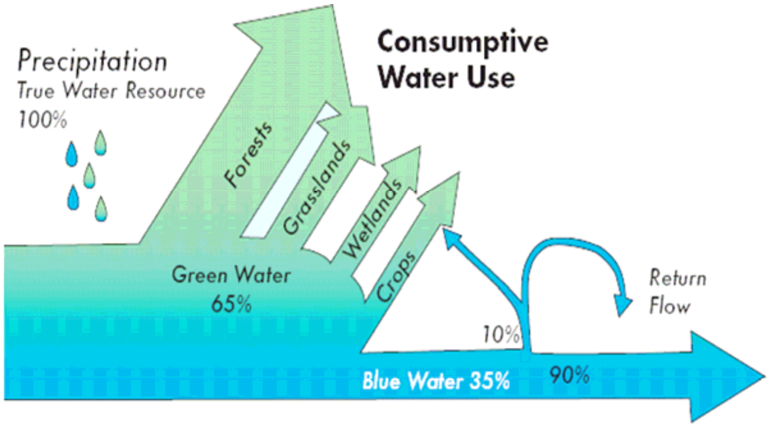
44 A list of national water savings due to international agricultural trade can be found in the Appendix.

45 See de Fraiture et al. (2004).

46 See Falkenmark (1995).

It can generally be said that it is easier to use blue water for alternative purposes than green water. Blue water can be transported and is therefore the only source for drinking water supply and can be used optionally in industry. In contrast, green water cannot be transported, which means that only the soil in which it is bound can be used for an alternative purpose or be cultivated. The only alternative to agriculture for its use is forestry or the preservation of ecosystems (e. g. wetlands). It must therefore be borne

Figure 6: Green and blue water resources



Source: Falkenmark / Rockström (2005)

in mind that green water has the advantage of limited opportunity costs.[47] Where the use of "green" water resources in rain-fed agriculture does not compete with the "preservation of an ecosystem", it is, in principle, preferable to the use of "blue" water for agricultural purposes from the point of view of resource economics. The use of blue water for irrigation, on the

47 See Chapagain / Hoekstra (2005).

other hand, calls for investment in infrastructure and is often associated with high opportunity costs.

It is difficult, however, to quantify "green" water resources, as Hoekstra and Hung point out.[48] Yet it can be said with some certainty that green water currently accounts for much of the water that is virtually traded, since some 80 % of the world's arable land is rain-fed and produces some 60 % of all food.[49] Gerten and Döll of the *Potsdam Institute for Climate Impact Research* (PIK) are developing a model-based, global, geographically detailed means of measuring green, blue and virtual water flows as part of a three-year research project[50] with the aim of closing this gap. The model is meant both to portray the present situation and to enable future scenarios to be established against the background of climate change and CO_2 enrichment of the atmosphere. The aim of the project is to gain a better understanding of possible links between and feedback from water scarcity and agricultural management or global water resources and agricultural trade.

It can generally be said that the typical subsistence crops, such as grain (excluding rice), are today grown largely by rain-fed means, while such export-oriented vegetable crops as paprika, tomatoes and beans need to be irrigated in the semi-arid countries exporting them. A change of growing system from typical rain-fed crops to irrigated crops, with the aim, for example, of achieving a higher value added per litre of water used is therefore not to be recommended if the difference in the opportunity costs of "green" and "blue" water sources is included. A positive view – from the angle of the sparing use of scarce water resources – should be taken only of efforts to produce more efficiently in irrigated farming or in rain-fed farming. The inclusion of the nature of the water source is therefore vital for the appraisal of Virtual Water Trade.

Other authors, such as Renault, consider the distinction between green and blue water to be less relevant, considering it more important whether and

48 See Hoekstra and Hung (2003).

49 See Obuobie / Gachanga / Dörr (2005).

50 "Consistent assessment of global green, blue and virtual water fluxes in the context of food production: regional stresses and worldwide teleconnections"; see http://www.pik-potsdam.de/~gerten/res.htm.

what alternative forms of use there are for water “saved” by means of Virtual Water Trade:

> *“Whatever the origin, the virtual water discussion should focus on water for which there is an alternative use and for which there is not.”*[51]

However, this statement by Renault ultimately leads to the same conclusion since, here again, the opportunity costs (of alternative benefits) are the deciding factor. All it does in this context is including a further perspective by addressing all alternative uses (outside as well as within agriculture).

5.1.2 The value of virtual water

To determine the potential and positive effects of Virtual Water Trade or of the strategic implementation of the concept, it is necessary to assign a value to virtual water. This can be done at various levels: at global level, on the production (or export) side and on the demand (or import) side. Various principles are conceivable for determining the value of virtual water.[52]

5.1.2.1 Principles for determining the value of virtual water according to Renault[53]

The first “principle of universal values” relates to the analysis and comparison of global flows of virtual water. It is appropriate at this juncture to set universal reference values for the quantity of virtual water in a given product. Analyzing the value for each individual product, with account taken of the variable factors referred to by Hoekstra, would hardly be feasible. As the question is how much water is used on the production side or how much can be saved on the consumer side, Renault proposes that the

51 Renault (2006), www.worldwatercouncil.org/virtual_water/question1/1.renault.1.htm.

52 What is important in this context is that it is not a matter of the value of water which is fixed by water prices, for example, but the value which the water saved as a result of virtual water trade has for other uses.

53 See Renault (2003).

Figure 7: The principle of the marginal return from water

$$VWV = \frac{1}{LMG(kg/m^3)}$$

(VWV = Value of Virtual Water, LMG = Local Marginal Gain of Water Productivity)

Source: Renault (2003, 81)

standard values should be set on the basis of water consumption in the countries producing most efficiently.

The “principle of the marginal return from water” takes account of marginal consumption at local level, since that is where the decision on the production of food is taken. It is here that the marginal return from water determines its value. The marginal return in this context is the increase in the total return which can be achieved by each additional unit of water used. This argues against the fixing of standard values and for a relatively precise local calculation. That value is not static in terms of space and time: it changes when food is, for example, stored, i. e. virtual water is “transferred” from productive to unproductive periods. Renault has established the following formula for this purpose:

The value of virtual water may also depend on the alternative uses to which the importers can put the water saved. The “principle of substitution” applies in this respect. The water saved cannot always be put to alternative uses in other sectors. The marginal return from water is then near to zero and so cannot help to increase profits. This is usually true of green water resources, since they are bound in the soil and therefore “immobile”. The value of virtual water can thus be determined on the basis of Renault’s simplified model (Fig. 8):

Figure 8: Analytical sketch of the substitution principle in the production domain

	→	On site substitution impossible (rainfall)	→	Little or no agricultural alternatives
On site green water	→	On site substitution possible (rainfall)	→	Water can be reallocated* / agricultural alternatives possible
External blue water	→	Reallocation possible (irrigation)	→	Water transfer possible* / agricultural and non-agr. alternatives possible

(*) Transfer and reallocation are bound by bio-physical conditions of the wateshed.

Source: Renault (2003, 83)

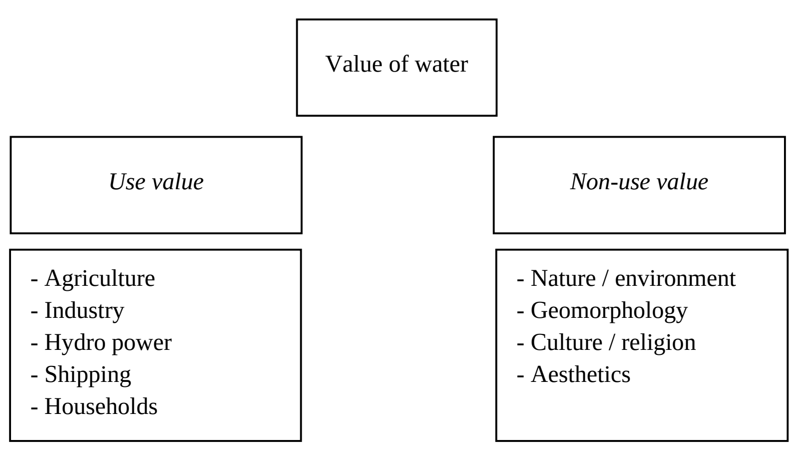
Of green water resources it can therefore be said that there is either no possibility of substitution or only negligible agricultural alternatives. In the case of blue water, on the other hand, there is very often the possibility of transferring the water to other locations and using it for alternative agricultural or industrial purposes.

5.1.2.2 Types of water values according to Agudelo

A more ambitious principle for determining the value of water saved is presented by Agudelo. In simplified terms, this principle has it that the value of water can be divided into two types: use value and non-use value:[54]

54 See Agudelo (2001).

Figure 9: Types of water value



Source: Agudelo (2001, 11).

Use values thus occur directly as a result of the consumption of the resource (as in agriculture) or of its service (as in the household). Within the use value category a further distinction can be made between consumptive and non-consumptive use. To a relatively high degree, water is used consumptively in agriculture and in the household, for example, but for industry the proportion of water, which is consumed, is lower and for hydro power or in shipping again lower or almost nil. Consumptive in this context does not, however, mean that water is physically present in the product or lost for all, but that it is – in a certain time frame – not available for other users or uses. This distinction is important for measuring the value of water:

> *"competition and complementarity across uses become important considerations in valuing water resources, because water can be used repeatedly or even simultaneously for different uses. Ideally, water resources should be examined in a full general equilibrium context, where all positive and negative externalities would be taken into account."*[55]

55 Agudelo (2001, 13).

Valuing water is particularly difficult in the case of the non-use types, since value is then based on the mere existence of the resource. The gains in this respect include an intact environment, the protection of biodiversity and the possibility of practicing traditional or religious rituals. As Agudelo notes, the non-use value is often regarded as part of the economic value of water and all types together therefore produce the total value of the resource.

It can be said, finally, that it is extremely difficult to assign a precise, definitive value to virtual water (whether water used for production purposes or water saved on the importer side). Depending on how this value is determined at global or national / local level, it can therefore be calculated no more than imprecisely how it differs from the value added by an alternative use.

Although it can be said in this respect that the value is comparatively irrelevant in ecological terms as long as only water resources are protected, the political decision for or against Virtual Water Trade will be based on economic benefit. Thus the higher the value of virtual water, the more likely it is that a country will opt to introduce Virtual Water Trade. Only if the value added by the alternative use of the water remains the same or rises does it make sense to advocate Virtual Water Trade and to employ it as a political strategy.

5.1.3 Alternative use as drinking water

It is noticeable that the most frequently encountered problem situation and alternative use of blue water resources attract little attention in the academic debate on Virtual Water Trade. This is the competition between irrigation water and drinking water that occurs periodically in many water-scarce countries and chronically in such Middle Eastern countries as Jordan. It must therefore be assumed that the water saved in these countries would benefit the drinking water supply. The provision of drinking water is valued differently depending on the tariff system used by the country concerned. Legislation usually provides that the use of water as drinking water must always have priority over other uses, regardless of the value added that could be achieved.

Politically and in practice, this alternative use of saved water as drinking water is of the utmost importance compared to the other uses. The decision on this is not, however, based on any thought of greater efficiency, but on what society regards as the use having priority.[56]

5.1.4 Use of water in the production of industrial goods

The main argument advanced by the proponents of Virtual Water Trade is that the water thus saved can be used more efficiently to produce industrial goods. A side-effect, they argue, is the contribution this would make to a thriving economy, since industrial goods have a greater value than agricultural products. The proceeds from industrial production could be used to finance, among other things, necessary food imports. Whether this idea is realistic depends on the current degree of industrialization of the country concerned. No country will be able to industrialize simply in order to use water more efficiently; it is the general economic environment that is important in this respect.

A major advantage of the use of water in industry and households is that it can be reused, and this in two senses: on the one hand, once it has been recovered, it can be used several times over before being discharged into rivers or drainage systems; on the other hand, it can also be reused from that point once it has again been recovered. As a rule, only a small proportion is lost in sewerage and cooling systems. In the US paper industry, for example, water was reused an average of 11.8 times in 2000, and in the chemical industry it may be reused as many as 28 times before being discharged.[57]

Taking South Africa as his example, Jobson shows that water can be used more efficiently in industry and results in higher value added per unit of water than in agriculture.[58] In 1995 the agricultural sector in South Africa accounted for about 72 % of all water used, but its contribution to the gross domestic product was only 3.9 %. In contrast, the industrial sector

56 See, for example, Youkhana / Laube (2006); Hummel (2005).

57 See Brot für die Welt (2003); Wallacher (1996).

58 See Jobson (1999).

consumed some 11 % of the total, but accounted for one third of the gross domestic product.

5.1.5 Use of water in the production of less water-intensive agricultural goods

Another way of using Virtual Water Trade strategically might be to grow agricultural products that need less water and to import water-intensive agricultural products. There are several projects in developing countries working on the diversification of agricultural production. This is not therefore a new idea. A tool for analysing the comparative cost advantages of agricultural production was designed for USAID by Hassan et al. (1999), for example. USAID also published a series on comparative economic advantages of alternative agricultural production options for several African countries.[59]

Furthermore, and to bring the water aspect into the analysis, Treitler has designed a model which measures the water efficiency of individual agricultural products and simulates socio-economic effects that would occur if more water-efficient products were substituted for them.[60] This is an ideal-type model which indicates alternatives in theory, i. e. without a specific context, but does not yet undertake an analysis of significant local conditions.

Individual products are first categorized according to their water efficiency, with the global average taken as the yardstick of efficiency. More efficient products are then substituted in the model for inefficient products. In Uganda’s case, for example, this shows that such water-inefficient products as maize, sweet potatoes and tomatoes could be replaced by more efficient products, such as millet, manioc and vanilla.

To determine which countries can produce the necessary staple foods that are water-intensive, Treitler proposes a different approach. On the basis of FAO and UNESCO data he has detected a correlation between water efficiency and gross domestic product. On this basis he considers it theoreti-

59 See USAID (1999).

60 The ViWa model was presented by Treitler at the first workshop at the German Development Institute on 7 September 2005.

cally possible to identify the "best performers" and involve them strategically in Virtual Water Trade.

A careful examination of the demand side, the possibilities for marketing alternative products and local production conditions shows it to be quite appropriate to propagate the growing of less water-intensive agricultural products in certain areas. There are already examples of successful changes of production. Yet here again considerable information on path dependencies needs to be gathered to make any interventions into local economies and adjustment to agro-ecological locations sustainable.

A policy of this kind, which relates to the growing of individual crops and, for example, pronounces bans or checks on the growing of certain crops because of their water requirements, can also be implemented regardless of any overall Virtual Water Trade strategy.

5.1.6 Other possible uses of saved water

Where the alternative use of green water is concerned, it may sometimes be appropriate to use land for grazing rather than the growing of crops, since meat attracts a far higher price per kilogram than grain, although significantly more water is needed per kilogram of meat. In other cases it may be wise to plant trees on pastureland as a nature conservancy measure or with a view to using the woodland commercially.[61]

Using soil, or the water bound in it, for an alternative purpose is not, however, always possible or more efficient, as Renault points out:

> *"There are cases though where there is no alternative, a good example of that was illustrated in a study by FAO on Mauritania, showing that this arid country is exporting virtual water through the trade of goats which are produced almost in a desert land taking advantage of little rain and small water streams on huge areas. Here there is no alternative for this water use than feeding goats."*[62]

Where water resources are not used commercially, as in the case of the extensification of agriculture, it is difficult to determine – as described

61 See World Water Council (2004).

62 Renault at www.worldwatercouncil.org/virtual_water/question1/1.renault.1.htm.

above – what value or added value this "alternative" use of water has. Added value may not, for example, be visible until some time in the future, if water resources are preserved for future generations or possible opportunity costs do not occur.

5.1.7 Monetary valuation of the preservation of ecosystems or man-made landscapes

The preservation of man-made landscapes, endangered habitats of threatened species of flora and fauna and the careful handling of scarce resources are in themselves values, but they are difficult to express in figures. One means of measuring this value is provided by the *Satellite National Accounts* (SNA),[63] with which ecological criteria were to be increasingly integrated into economic analyses:

> *"In brief, these satellite national accounts attempt to estimate the value of the degradation and enhancement of environmental capital, for example the degradation or enhancement of a water resource. They argue that a better evaluation of the real costs and benefits present in economies and societies can be gained by taking a more comprehensive view of what the inputs to and the outputs of an economic enterprise are […]."*[64]

A man-made landscape, or its preservation, may benefit society in many ways. For one thing, regional and social identity is imparted through the man-made landscape:

> *"Identifiable landscape images, familiar historical ensembles or especially pregnant elements of the man-made environment serve as symbols of the constitution of 'home'."*[65]

The man-made landscape may also contribute to regional economic sustainability where, for example, it becomes part of what the country has to

66 For further information on SNA see United Nations Statistics Division at http://unstats.un.org/unsd/sna1993/toctop.asp?L1=21.

64 Allan (2002, 201f.).

65 Bundesamt für Bauwesen und Raumordnung (*Federal Ministry of Building and Regional Planning*) at http://www.bbr.bund.de/veroeffentlichungen/izr/5_6izr1999.htm.

offer tourists and so a "soft locational factor". Studies by Barbier and Thompson and by Acreman[66] have shown

> *"[...] that in some cases the values generated by irrigation proved to be less than the values generated by the ecosystems they replaced."*[67]

The efficiency concept therefore represents only one of a number of ways of defining what constitutes appropriate water use. This may, after all, consist in the conservation of nature or in the use of water as drinking water. It cannot be defined by reference to the criterion of efficiency alone. Until, therefore, the external costs of environmental consumption or the destruction of biodiversity are taken into account in the economic calculation, the criteria of the preservation of the environment and life as such will join the efficiency criterion as qualitative objectives.

5.2 Prevention of geopolitical conflicts at regional, national and local level

A much quoted argument for the urgency of sustainable resource use is the major potential for conflict due to the growing scarcity and pollution of water in various countries and regions. Some countries, Jordan being an example, use more water than can be regenerated, which results in competition among water uses and users. Virtual Water Trade employed strategically might help to defuse this competitive situation in certain places. Where, for example, a country reduces irrigation in its agricultural sector, the resources thus saved are released for other uses and users and an emerging conflict can be averted.

5.2.1 Reducing the potential for international and regional conflict

5.2.1.1 Growing demand for water resources

The potential for conflict over water is regarded as particularly pronounced for several reasons. One is that water is a resource which everyone needs in his daily life and to survive, either as drinking water or to

66 See Barbier / Thompson (1998) and Acreman (2000).

67 Molden / de Fraiture (2004, 4).

produce food. Added to this, both qualitative and quantitative demand for water is rising steadily as the global population grows. In the two decades between 1980 and 2000 alone water consumption throughout the world rose by 30 % from 2,120 km^3 to about 2,700 km^3.

> *"Of some concern is the forecast that the human consumption of water may again triple in the next 30 years. At least 40 % of the world population will then live in countries where there is chronic water scarcity."*[68]

The growing demand for processed products and consumer goods in such newly industrializing countries as China is also contributing to the overuse of water resources. For the production of one ton of beef, for example, about 16,000 m^3 of water is needed, while only about 3,000 m^3 is required to grow one ton of rice.

In general, then, strategic Virtual Water Trade might prevent the growing demand from giving rise to conflicts over water. However, the people concerned would have to have the financial resources to acquire food, or fresh conflicts can be foreseen. In many cases these requirements dampen realistic expectations of Virtual Water Trade succeeding and show that the concept is appropriate only as a small component of a more comprehensive strategy.

The evidence in many regions and countries also reveals that violent conflict between different water users within individual countries is far more likely than conflict between different countries. This is partly due to formal arrangements and effective agreements already existing between many countries, though very rarely between water users within one country (e. g. between users up- and downstream).

5.2.1.2 Cross-border use of water resources

Barandat estimates that 50 % of the world population use cross-border water systems.[69] The same is true of groundwater reserves, which often

68 Brot für die Welt (2003, 3).

69 See Barandat (1997).

extend across several countries. The 261 cross-border rivers that exist throughout the world provide some 60 % of surface freshwater resources.[70]

Experience so far shows that, as military conflict between countries over water is extremely rare, it can be regarded as relatively unlikely. To prevent it, there are some 3,600 international agreements governing the use of cross-border bodies of water.[71] Even in regions hard hit by water scarcity, such as the Middle East and North Africa (MENA), there are agreements which explicitly govern the joint use of water resources, but usually as part of more complex issues:

> *"In this core [MENA] region the management of water became a significant economic and environmental challenge in the second half of the twentieth century. As a result water has gained a prominent, but by no means determining, place in discussions of the international affairs of the region […]. But the deduction that serious, and even armed, conflicts would be the response to the growth of water demand beyond the capacity of the region to meet its population driven water needs […] have proved to be unfounded."*[72]

Aaron Wolff in particular has also shown with his empirical studies that negotiations on cross-border waterways often act as a catalyst of cooperation rather than as causes of conflicts.[73] However, as the resulting agreements do not as a rule deal fully with water issues, differences of interest are only partly reconciled, as El-Naser points out in his statement:

> *"A common denominator [...] is the absence of comprehensive riparian agreements that regulate the rights and responsibilities of each in water sharing, environmental protection, inefficient use, exchange of data and the avoidance of inflicting appreciable harm upon co-riparians."*[74]

This can be seen, for example, in the case of the three neighbours Turkey, Syria and Iraq. The rivalry over the use of the water from the Euphrates and Tigris has so far given rise only to bilateral agreements, not to a cooperation agreement signed by all three countries. What is particularly criti-

70 See Klaphake / Scheumann (2001).

71 See UNESCO / IHP / WWAP (2003).

72 Allan (2002, 264 f.).

73 See Wolff, (1998).

74 El-Naser (2005, 2).

cal in this context is that the sum of the water resources officially claimed by each country clearly exceeds the water actually available from the two rivers.[75] One reason for this is that there is no consensus among the three countries on the data concerning the quantity of river water available.

The water is used in all three countries primarily to irrigate areas used for agricultural purposes. In Iraq especially it is, however, questionable whether the soil is in fact suitable for irrigated farming in the long term. A change in Iraq to the import of more agricultural products, i. e. Virtual Water Trade, might therefore resolve the conflict and have additional ecological advantages. The introduction of strategic Virtual Water Trade might also trigger a general political dialogue if these countries were to meet for trade negotiations.

Yet this example in particular shows that negotiations on jointly used water resources are often strongly influenced by economic and political interests and are the expression of a political trial of strength. The protection of resources attracts little attention in this context. The decision whether one of the countries introduces Virtual Water Trade is thus linked to more comprehensive political and economic determinants. A regional strategy in particular might therefore have to be associated with broader concessions, such as a guarantee of political independence, which cannot, however, really exist at a time of globalization.

5.2.2 Preventing local conflicts

Local conflicts over water between individual users and sectors, violent in some cases, are likely to escalate in the future unless conflict resolution strategies are employed.[76] Resource scarcity is not always the consequence of declining absolute supply or increased demand, but may also be due to

75 This was demonstrated by Waltina Scheumann in her paper for the conference of the *Academy for Political Education* at Tutzing (Bavaria) on 3/4 February 2006 on the "Struggle for Water". She also made it clear that the conflict might be resolved by Turkey's accession to the European Union, since it would then have to comply with paragraph 35 of the EU's framework water directive, which provides: "For river basins extending beyond the boundaries of the Community, Member States should endeavor to ensure the appropriate coordination with the relevant non-member States." (See http://www.umweltbundesamt.de/wasser/themen/wrrl-d.pdf).

76 See, for example, Selby (2005).

inadequate resource management, poor coordination and poor allocation. Mismanagement is one of the main causes of local conflicts over water resources. Youkhana and Laube give various examples of possible breeding grounds for conflicts.[77]

Taking Burkina Faso as their example, they describe how the expansion of agriculture in the rural areas of the South has triggered conflicts between farmers and cattle breeders over water, the cattle breeders having been driven from their traditional grazing land and now competing with the farmers in the North of Ghana for watering places. In Ghana, too, there are conflicts between small and large farmers, both claiming rights to use land and water, between ethnic groups and even within the local farming population.[78] Similar conflicts are described by Neubert et al. along rivers in Kenya.[79]

Other conflicts are occurring with greater frequency in peri-urban areas, where increasing settlement is leading to competition between water management for the settlers and irrigated agriculture. An added factor is that the chemicals used in agriculture have a serious adverse effect on the quality of drinking water.

In urban areas in particular social tensions may arise because of poor management of drinking water supplies and sewage disposal, since proper sanitation is not adequately ensured in poorer districts:

> *"The unplanned growth of many cities, inadequate maintenance of existing infrastructure, profit-oriented management and political influence often result in quarters inhabited by the poor and migrants having no reliable drinking water supply. Fair distribution in the provision of drinking water and the increasing privatization of water suppliers are phenomena encountered globally, representing considerable potential for conflict."*[80]

Youkhana and Laube come to the conclusion that only in certain circumstances is Virtual Water Trade likely to resolve local conflicts over water resources. The main reason for this is that actual water scarcity is rarely

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77 See Youkhana / Laube (2006).

78 See UNEP (2002).

79 See Neubert et al. (2006).

80 Youkhana / Laube (2006, 5).

the cause of such conflicts, which are due rather to poor infrastructure, inadequate management and, associated with those factors, inappropriate allocation. Such organizational problems may also occur where there is trade in virtual water; indeed, their occurrence in that case seems even more likely, since it is then also important for coordination tasks to be performed, and dependencies among them tend to grow.

Youkhana and Laube point out that local Virtual Water Trade is already practiced in many cases of acute water scarcity, with food being "imported" from water-rich regions to regions with less water. The authors consider that such measures could be expanded "on a small scale, governed by the rule of law and with appropriate support measures".[81]

Virtual Water Trade must not be inconsistent with efforts to implement the concept of Integrated Water Resource Management (IWRM). At national level it requires a legal basis and central control to ensure the fair allocation of imported food. What remains unclear, for example, is the role of organized groups of water users, who should, according to the Dublin principles,[82] be involved in the sustainable management of local water resources:

> *"Finally, it must be emphasized that in recent years IWRM measures in many developing countries have prompted water reform processes one of whose main aims is the introduction of decentralized structures. While there is no desire here to appraise these reform processes, a question that remains open concerns the extent to which the strategic introduction of 'virtual water trade' as a national adjustment strategy conflicts with the idea of decentralizing decision-making structures and accountabilities."*[83]

81 Youkhana / Laube (2006, 7).

82 Principle No. 2: "Water development and management should be based on a participatory approach, involving users, planners and policy-makers on all levels."

See: http://www.gwpforum.org/servlet/PSP?iNodeID=1345.

83 Youkhana / Laube (2006, 8).

5.3 Promotion of South-South trade and regional strategies

As already mentioned, Virtual Water Trade can form part of a regional development strategy, ideally within regional economic communities. Earle and Turton and Malzbender consider it possible in principle to implement such a regional strategy in the SADC (Southern Africa Development Community) countries.[84] This would promote trade in the region in line with comparative advantages and also contribute to increased economic growth:

> *"The SADC states with large supplies of internally generated water have GDPs of US$ 300 per person or less, placing them in the category of least developed nations. The rich SADC states, with GDPs per capita of US$ 2,500 and above, are either dry or heavily reliant on external water sources. There has been very little exploitation of this disparity between states of water resources and income levels."*[85]

Potential exporters of agricultural products might be the economically less developed, but water-rich countries: Zambia, Mozambique, the Democratic Republic of Congo and Angola. The economically relatively strong countries, South Africa, Botswana, Namibia and Zimbabwe, could import more food, since they have the institutional, economic and human capital to use saved water in other sectors of the economy.[86] The European Union's pledge at the world trade conference held in Hong Kong last year to abolish agricultural subsidies by 2013 could increase the African countries' competitiveness and improve the chances of flourishing South-South trade.

It must not be forgotten, however, that the formulation by Earle and Turton and by Malzbender of possible scenarios for regional Virtual Water Trade is based predominantly on the fact that some countries of the region are water-scarce, others water-rich. This is not to say that the potentially exporting countries also have the economic, social or political means or the infrastructure to implement the strategy. Although Zambia, for example, has enormous potential for the export of virtual water, the infrastruc-

84 See Earle / Turton (2003) and Malzbender (2005).

85 Earle / Turton (2003, 188).

86 See Earle / Turton (2003).

ture is unequal to the task of affecting those exports. Pursuing such a strategy would therefore require investment and considerable patience.

5.4 Prevention of non-sustainable water recovery projects

Virtual Water Trade may help to prevent unsustainable or very costly projects for the generation of water resources, since it would mean abandoning the paradigm of self-sufficiency in food hitherto used to justify investment even if it was not sustainable. If irrigated agriculture was cut back in arid and semi-arid areas and, instead, more virtual water was imported, many future dams and pipelines would become superfluous. The financial resources provided for such projects could then be used to finance imports of virtual water.

According to a study carried out by the *World Commission on Dams* (WCD) in 2000, the desired objectives of improved and more productive irrigated agriculture are often not achieved through the construction of dams:

> *"Irrigation components fell well short of targets in terms of irrigation command area developed, actual irrigated area achieved and to a lesser extent, the cropping intensity."*[87]

Particularly large dams, many of which are prestige objects of the governments concerned, come in for extremely harsh criticism from the WCD. Apart from the enormous financial costs associated with the construction of a dam, it is frequently accompanied by adverse ecological and social effects, such as the resettlement of people. On the ecological consequences of the dams examined, the WCD comments:

> *"For 87 projects almost 60 % of the impacts identified were unanticipated prior to project construction. Furthermore two thirds of the anticipated ecosystem impacts occurring had negative consequences."*[88]

The physical transport of water in pipelines and tanks is also a costly and inefficient form of water allocation. The desalination of sea water is similarly not a financially sustainable strategy for meeting demand in agricul-

87 http://www.dams.org/kbase/survey/ccs_exec.htm.

88 ibid.

ture. The salt water concentrate (brine) returned to the sea, often badly contaminated by chemicals, also damages the environment.

Virtual Water Trade can therefore help to save financial resources in these spheres and to ensure that they are invested more effectively in, for example, the expansion of existing irrigation infrastructure. During any assessment of the implications of the technology involved in the construction of such infrastructure, a problem-oriented approach should therefore be adopted and a comparison made with the alternative of increased Virtual Water Trade.

5.5 Compensating for periodic or short-term shortages of staple foods or water

Periodic or short-term shortages of staple foods and water are often closely linked, especially in arid and semi-arid countries. Famine in Africa, for example, is frequently triggered by the absence of or too little rainfall, though the root causes are mostly governance problems. Advocates suggest that for countries affected Virtual Water Trade may be a way out of these critical situations. In other words, there does not have to be sweeping change in the agricultural sector: trade can also be used when the need arises.

This could be done in two ways. Either Virtual Water Trade would be put into practice – in much the same way as food aid in the event of a disaster – when a shortage arises or is expected. Agricultural products, for instance, might then be imported from neighbouring countries or bought in the world market. However, the virtual water could also be stored in the form of food (having been bought by the state, for example) and so transferred at times when water or food was scarce. Food can be stored far more cheaply and over longer periods than water and can therefore act as a reserve.

Food supplies are in effect already being used to bridge periodic shortages in the supply of staple foods. As an *ad hoc* measure, however, a request usually goes out for food aid from outside, with the familiar adverse effects on the incentive structure for national agricultural production. Systematic internal Virtual Water Trade, which would probably have to be subsidized by the state, could, however, help to suppress external food aid and to ensure that better use is made of the domestic potential at appropriate favourable locations. This idea is not new, however, having long been the suggested policy for drought-prone countries. Yet reality in those countries is such that logistical problems, poor infrastructure and the absence of political will very often impede the implementation of such mitigating policies. In 2006, for example, millions of Kenyans in the north-eastern parts of the country suffered from famine, while thousands of tons of food were rotting in the Central Province. Although Virtual Water Trade would be the answer here, it has to be initiated and promoted *before not after* the cattle starve if a situation in which the herders affected have nothing left to trade is to be avoided. In this scenario, then, governance is the bottleneck, i. e. a minimum of forecasting and information-sharing organized by an administrative unit is needed to make Virtual Water Trade beneficial.

Such subsidization of the internal transport of food with a view to avoiding external food aid also contrasts with the possibility of subsidizing local irrigation projects, which might enable vulnerable people to become productive and so less susceptible to drought and famine. The social gains from such an approach may, however, contrast with scarce natural resources. But in other cases sufficient groundwater reserves may be available for use at least temporarily to enable people to take income-generating measures by means of irrigation. In the longer term it would nonetheless be appropriate at some places to help these people to find work outside agriculture.

As the previous section shows, there is no blueprint that can be applied generally: instead, a problem-oriented view, with account taken of all the options discussed, would again be the appropriate approach.

5.6 Virtual Water Trade as a substitute for food aid

Besides the bridging of periodic or short-term emergency situations, one of the aims of food aid is to ease the pressure on the trade balance of developing countries through import substitution, so that scarce foreign exchange reserves can be used for investment.[89] In the envisaged process of

89 See Schug / Léon / Gravert (1996).

restructuring the export sector (see Chapter 6.2.1), however, they might also complement each other. The advantage of this would be that the possible adverse consequences feared in the case of Virtual Water Trade and actually observed in the case of food aid supplies might be mitigated.

As will be described in some detail in Chapter 6.5, critics of the concept emphasize in particular the possible negative social implications of strategic Virtual Water Trade for the rural population. They may occur where, in the event of a reduction in agricultural production, redundant smallholders and workers cannot be absorbed by the industrial and service sectors. Although the concept provides for a higher value added to be achieved with the saved water, this idea is too simplistic and does not include the complex economic environment which is, however, decisive for the development of the industrial sector. It is conceivable nonetheless that the foreign exchange saved as a result of food aid will flow into the industrial sector. Virtual Water Trade might then be gradually increased until it eventually took the place of food aid. The result would be the progressive elimination of the adverse consequences of such aid, especially in the case of “bulk supplies”.[90]

With food aid replaced by Virtual Water Trade, South-South trade could also be promoted. As Meissner points out, the USA’s food aid supplies to the countries of the SADC region halved South Africa’s exports to this region in 2003.[91]

6 Strategic Virtual Water Trade: challenges and risks

6.1 How far can development be planned?

Changing from agricultural to industrial production is not possible at the flick of a switch; nor can it be easily planned or controlled, as is evident from the persistence of many world problems with which we generally

90 For example, the USA supply steadily, not only at times of shortages, surplus food to the SADC region free of charge under the World Food Programme, which destroys prices in that region. What is also important, therefore, is that agricultural subsidies which have a similar effect be abolished so that virtual water trade may be arranged appropriately. See Meissner (2005).

91 See Meissner (2005, 8).

have to contend despite proposals for solutions. At any rate, the processes concerned are slow. Given the wide variety of environments, Kluge and Liehr therefore call for "a regionalized examination of the purpose of Virtual Water Trade and its socio-economic requirements."[92]

In many developing countries a sizable proportion of the population work in agriculture to meet their own food requirements. Although subsistence farming is excluded from the economic circuit in this context, it contributes significantly to the reduction of scarcity. A major part of income is substituted in this way.

For such people – and thus, clearly, for very poor developing countries in general – Virtual Water Trade is ruled out, since it would be accompanied only by disadvantages, e. g. more dependence and more poverty, these sections of the population having few alternatives to agriculture:

> *"The great path dependence as a consequence of long, often intergenerational periods between impulses for change and the emergence of positive or negative effects in the various sectors of society is an indication of the difficulty and, at the same time, considerable importance of present decision-making and action. From this it is evident that the manner in which rural development occurs […] lays the foundations for the country's continued social development […]."*[93]

Major challenges and risks faced by water-scarce developing countries will be considered in the following sections.

6.2 Economic requirements for Virtual Water Trade

A critical point in the debate on the chances of developing countries engaging in strategic Virtual Water Trade is the question of how to compensate for the consequent foreign exchange expenditure. To an extent, reference can be made in this context to the debate on food aid, since the very fact that many developing countries suffer from a shortage of foreign exchange and from debt servicing is one of the main reasons for their often being unable to handle food distribution commercially.

92 See Kluge / Liehr (2005, 13).

93 Kluge / Liehr (2005, 6 f.) with a reference to World Bank (2000, 105).

From an economic point of view it can therefore be said, first, that international strategic Virtual Water Trade is in the short term a realistic option only for water-scarce countries with sufficient foreign exchange reserves. This is true, for example, of the oil-exporting countries of the Middle East (e. g. Iraq and Saudi Arabia). For poor countries with scarce water resources international strategic Virtual Water Trade is not an option and could be introduced, at best, in a very long drawn-out process. However, national and regional Virtual Water Trade has some problem-solving potential, which certainly seems relevant.

6.2.1 Necessary restructuring in the export sector

If saved water is to be used to enable investment for the promotion of the export sector, it can be used – as already mentioned – both in the production of more water-efficient agricultural products and in the export industry. Concentrating on strengthening the export sector makes sense to the extent that the foreign exchange revenue needed for virtual water imports can then be generated.

Given the determinants of the development of import and export markets (based on the Heckscher-Ohlin theory of comparative cost advantages), which have already been discussed in Chapter 3.2, the possible form and duration of the restructuring of individual national economies will have to be examined. For countries which already have a relatively well developed industrial sector it is likely to be less difficult to continue expanding that sector and to use in it the water saved through Virtual Water Trade. Various authors have shown that industrialized countries use their water resources more efficiently than others. Turton points out that water supply may be a relevant determinant of a country’s economic development:

> *“This different SWE (Sectoral Water Efficiency) characteristic allows the notion of economic gearing to be brought to bear on the problem of water deficit. This in turn implies a better water use pattern, and in particular, the ability to generate foreign currency with which to finance Virtual Water imports.”*[94]

94 Turton (2001, 7).

However, countries in which a large proportion of the population is employed in agriculture may initially be able to do no more than change their agricultural production and grow more water-efficient crops. Yet this can save water resources only if the shift occurs *within* the irrigation sector or *within* the rain-fed sector. If the change includes a shift from the use of green water (rain-fed) to the use of blue water (irrigation), the effect will be somewhat negative, since it is accompanied by a shift from low to high opportunity costs, as explained in Chapter 5.1.1.

Brüntrup stresses additional problems, when it comes to changes of production patterns:

> *"[...] structural change from agriculture to industry is probably one of the most radical transformations a society can undergo. Agricultural production usually on a small scale, spatially scattered, equipped with traditional know-how and simple technology and including a large proportion of subsistence production has to convert itself into a market-oriented, know-how-intensive economic structure based on a division of labour and guided by capital accumulation. Most of the poorer developing countries, especially in sub-Saharan Africa, have not yet advanced very far in this transformation. [...] Economic adjustment processes, let alone shifts between the agricultural and other sectors, cannot therefore be expected to occur quickly and without major frictional losses. This is not an absolute argument against structural change, as a push for virtual water trade would entail, but it does make it clear that the difficulties associated with and therefore the cost and duration of adjustment will be very considerable."*[95]

These adjustment difficulties might be further exacerbated by the lack of diversification in many developing countries. Brüntrup (*loc. cit.*) emphasizes that on average the least developed countries (LDCs) earn 70 % of their export proceeds from only three products, and more than half from only one. In the UN General Assembly, too, it was stated in 1995:

> *"LDCs as a whole have made limited progress in overcoming structural constraints, infrastructural insufficiencies, debt overhang, promoting and diversifying the enterprise and export sectors, attracting foreign investment and creating a sufficient technological base. In this context,*

95 Brüntrup (2005, 6).

most of the LDCs will face globalization and liberalization from the situation of a constrained environment." [96]

The requirements that have to be satisfied for Virtual Water Trade to function internationally are therefore immense and, moreover, uncontrollable. It is important to emphasize this at this juncture to prevent the link to reality from being overlooked in the overall debate. But it is also becoming clear in this context that for the LDCs Virtual Water Trade is conceivable only in very specific instances or only in the long term as part of the development process being pursued (e. g. diversification of the export sector).

6.2.2 Necessary labour market and income structures

It is important to take account of the structure of the labour market and of incomes if Virtual Water Trade is to be made socially absorptive. This is discussed in depth in Chapter 6.5. The development of these structures is closely linked to the restructuring of the export sector, since the latter will give rise to particularly sweeping changes for the people. The more water imported virtually, the more jobs lost in the agricultural sector. Hence there would be the need to find places for redundant workers in other sectors. But what other sectors have this absorptive capacity? The debate on development in Africa in particular tends to lead to the conclusion that the agricultural sector or the sectors up- and downstream are often the only ones whose development offers a chance of broadly effective growth (pro-poor growth debate).[97]

6.2.3 Necessary markets for alternative non-agricultural products

An important requirement for the sustained and effective introduction of strategic Virtual Water Trade is the existence of markets in which any product substitutes can be sold. If, for example, the water saved is to be

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96 See http://daccessdds.un.org/doc/UNDOC/GEN/N96/764/83/PDF/N9676483.pdf?OpenElement

97 For further information on the pro-poor growth approach see, for example, www.worldbank.org/propoorgrowth, and Altenburg (2005).

used in the manufacture of industrial products, markets for them must be identified beforehand. It also depends on the other factors of production – labour, land and capital – whether the goods can be competitive in the market, since these factors partly determine the price.

6.3 Political will as a condition for Virtual Water Trade

6.3.1 The credo of food sovereignty

In many countries a high political and social position is assigned to agriculture even when it is not economically profitable and needs subsidies. There are many underlying reasons for this. In Germany the subsidies exist officially to reward agriculture for its contribution to the preservation of the man-made landscape and biodiversity. Furthermore, farmers' livings are to be guaranteed for social security reasons.

In newly industrializing countries in particular agricultural production often fails to break even and contributes a declining share of gross domestic product. In many such cases introducing Virtual Water Trade as a political strategy would be appropriate. It would enable valuable water resources to be saved, especially in the MENA region. As El-Naser points out in his statement, agricultural production costs in the MENA region are higher than world market prices, partly because of the western industrialized countries' agricultural subsidies.[98]

As the MENA region has continued to pursue the goal of self-sufficiency, food is still being produced there. Where a water-scarce country increases its imports of food, it makes itself dependent on world market prices, or on individual trading partners.[99] A condition for strategic Virtual Water Trade is therefore the political will to abandon the paradigm of self-sufficiency. The degree of resulting dependence is determined by the political and economic weight that the country concerned is able to introduce into the relationship. According to Hummel:

> *"Not all arid and semi-arid regions have the same opportunities to participate in virtual water trade, since the economic and political interests*

98 See El-Naser (2005).

99 See Hummel (2005).

> *[...] and the development policy objectives of the 'donor countries', their policy on agricultural subsidies and even geopolitical power structures associated with agricultural trade have considerable influence on the chances of virtual water trade being introduced and succeeding."*[100]

In such cases, the diversification of import sources might prevent individual exporting countries from gaining quasi monopolies on importing countries' food supplies.[101]

Hoff, El-Fadel and Haddadin argue that the MENA region is already heavily dependent on virtual water imports.[102] Turton, too, points out that the trend is changing from the credo of self-sufficiency to food autarchy, i. e. the ability to provide sufficient food for the population both through domestic production and by importing.[103] A condition for strategic Virtual Water Trade would therefore be in these cases not so much the abandonment of the credo of self-sufficiency as giving it a different style and then actively stepping this up by means of political measures:

> *"In any case we would like to repeat that the dependence on virtual water is already very high in the MENA region, with none of the MENA countries currently being self sufficient in food production, i. e. having equilibrium between food imports and exports. There are a few countries with the potential to achieve self sufficiency, like Iraq, Syria and Lebanon, but all other MENA countries depend on net imports of virtual water, sometimes with a dependency of 80 % and more of their total water requirements. So the virtual water discussion is not about establishing a new mechanism that creates a new dependence, but more about an incremental increase."*[104]

100 Hummel (2005, 8).

101 See World Water Council (2004, 11).

102 See Hoff / El-Fadel / Haddadin (2006).

103 See Turton (1999).

104 Hoff / El-Fadel / Haddadin (2006, 4).

6.3.2 Reliability of food supplies and markets

A further decisive aspect is the ability to plan and rely on food supplies and markets, especially when it comes to supplying a country with staple foods.

What needs particular emphasis in this respect is that in many cases trade barriers may hamper the supply of food. Malzbender says as much, for example, with regard to the possibility of regional Virtual Water Trade within the SADC region:

> *"The conditions for cross-border trade between SADC countries are currently far from optimal for the implementation of a virtual water trade policy. Even if the four named countries were able to produce enough food […] for export, inter-regional grain trade would be impeded by the numerous trade barriers still in place. In terms of the SADC Trade Protocol member states are required to establish a free trade area by 2008 and establish a customs union by 2012. However, according to the Permanent Secretary in the (Botswana) Ministry of Trade and Industry, Banny Molosiwa, all member states are behind schedule in terms of taking the appropriate steps to establish the free trade area (Balise 2005). Some countries have postponed tariff reduction, because of their heavy reliance on tariff income."*[105]

A close look therefore needs to be taken at the risks faced by the potential importers of virtual water and the means of minimizing those risks. For this it seems essential for laws and policies relating to a Virtual Water Trade strategy to be harmonized and for a better environment for regional and global trade in staple foods to be created.[106] Only then is the political will to implement the strategy likely to emerge in some countries. Botswana and South Africa have already included a passage to this effect in their legislation. South Africa's *White Paper on Water Policy* (dating back to 1997) states:

> *"Where water is needed to produce water-intensive products such as food, wood and electric power, <u>it may be a more efficient use of resources to import them, rather than attempt to produce them in a water-stressed area</u>. This use of trade between countries and regions as a*

105 Malzbender (2005, 7).

106 See Malzbender (2005, 10).

> *measure to achieve best use of water has not been properly studied in Southern Africa."*[107]

It is clear, then, that South Africa is not yet taking optimum advantage of the Virtual Water Trade option, but approaches to its introduction already exist.[108]

6.3.3 Market access and generation of export proceeds

Where a water-scarce country reduces its agricultural activities in favour of the increased import of virtual water and instead produces higher-value products for export, there is a danger of its not gaining access to the world market for these products. Familiar causes of this are inadequate trade liberalization and often the stringent standards to be met, especially in the markets of the industrialized countries.

These export products must be marketed, however, to finance the imports of virtual water. Conversely, it is important for the exporters of virtual water that the importers are reliable customers and able to generate foreign exchange in the long term to pay for the food.

> *"[…] it has to be remembered that is not primarily countries that trade, but the private sector. Businesses that currently import food […] from outside the region will only shift to regional suppliers, if these can offer competitive prices. The development of a competitive agricultural sector and a well-functioning regional trade regime as emphasised above, are therefore even more crucial. The matter is made more difficult by the distorted nature of international trade in agriculture under the WTO Agreement on Agriculture and other WTO agreements. The long-term developments in the international trade arena therefore need to be well*

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107 White Paper on Water Policy, at http://www.polity.org.za/html/govdocs/white_papers/water.html?rebookmark=1; authors' underlining.

108 In the wake of this new water legislation prices are being charged for water and its supply, and since 2004 water has also been rationed. To prevent poor sections of the population from suffering, a graded tariff system has been developed, and support programmes for the poor have been introduced. In 2000 the *Stockholm Water Prize* was awarded to the then Minister for Water Affairs and Forestry, Kader Asmal, on whose work the reforms in the South African water sector are largely based. See Stockholm Water Front, 2000.

> *understood and integrated into the required multi-sectoral policy making process."*[109]

On the whole, then, further steps need to be taken to open up markets at regional and global level.

6.3.4 Hydropolitical requirements

As Allan frequently argues, a problem preventing the sustainable management of water resources, especially in the MENA region, is that there is little public discussion on the scarcity of water. Allan calls this a *"sanctioned discourse"*, by which he means that, although there is awareness among politicians and researchers of the growing scarcity of water resources, discourse in public is avoided for strategic reasons.

> *"The addition of the word sanctioned, though tautological, 'emphasises' even more the limitations on those speaking publicly about water policy."*[110]

This has various causes. One is that in many countries, as in the MENA region, the use of water is closely linked to the use of land and so to formal and traditional land use rights. Old-established farming families often have considerable social and political influence, making it difficult for political decision-makers to introduce rules on or prices for the use of water. Another cause is that the idea of self-sufficiency and independence from other countries, especially in the MENA region, is a question of self-esteem – even though in fact there is often no self-sufficiency or independence – which makes a public debate on water scarcity politically sensitive.[111]

With respect to the MENA region Allan therefore makes a distinction between two types of political priority, those which are economically and ecologically logical and those which are politically feasible.[112] To achieve water security, it is above all necessary, according to Allan, to ensure the supply of virtual water to the people by means of international and re-

109 Malzbender (2005, 10).

110 Allan (2002, 183).

111 See El-Naser (2005, 5).

112 See Allan (2002, 184).

gional cooperation. He justifies this by referring to the urgency of the need to conserve water resources. Only as second and third solutions should the efficiency of allocation (through demand-oriented approaches) and of production (through improved technologies and institutions or through prices) be increased. Allan points out, however, that governments and political decision-makers in the region are setting their priorities in precisely the reverse order because of the "sanctioned discourse":

> *"The contrast with the priorities articulated by politicians and professionals from the MENA region is stark. […] Productive efficiency is the popular and everywhere lauded solution to the region's water deficit. It is the prime priority for a number of reasons with most of them aligning with the national water discourse."*[113]

In much the same way as Allan, El-Naser argues that an improvement in water management in the MENA region can hardly be achieved through a public discourse or awareness-building.[114] He makes it clear, however, that, in these circumstances, an improvement in the efficiency of production (through the introduction of drip irrigation, for example) should initially take priority, since it has a realistic chance of being achieved. Strategic Virtual Water Trade should consequently form part of an overall strategy for improving water management and coping with water scarcity. He pins his hopes primarily on the younger generation in this context.

> *"The more logical solution for the MENA region would be to gradually transit into adopting the virtual water theory. […] It is time for the MENA region to realize the urgency to adopt and implement a long term plan and create new water policies to overcome the water scarcity problem with the underlying aim of changing the mindset of the young generation farmers."*[115]

Institutional reforms and capacity-building are essential instruments for sustaining policies, programs and projects.[116] Hoff, El-Fadel and Haddadin go even further and call in this connection for a political strategy of

113 Allan (2002, 186 f.).

114 See El-Naser (2005).

115 El-Naser (2005, 6 f.).

116 See El-Naser (2005, 2).

Virtual Water Trade to be implemented not in isolation, but as part of an overarching, integrated system of water and land management.[117]

On the whole, the debate on the MENA region reveals the dilemma faced by approaches to improved water resource management. Ecologically appropriate measures often fail because of political hurdles. Approaches that tend to be of a curative nature are therefore preferred, even if they are less sustainable.

6.4 Virtual Water Trade and security of distribution

Virtual Water Trade requires a reliable supply of food. Current organizational and infrastructure problems, however, would result in an insecure distribution situation in many developing countries, especially in rural areas.

6.4.1 Infrastructure and institutional requirements

To ensure the appropriate distribution of imported virtual water in the form of food, nation-wide infrastructure is essential. In the sub-Saharan African countries in particular providing the infrastructure to forge links with the hinterland is a major problem. This concerns not only roads and other transport facilities but equally telecommunications, storage and marketing infrastructure.[118]

In South Africa, for example, an obstacle to national Virtual Water Trade between the water-rich North and the water-scarce South is the high cost of transport. Importing grain from abroad is cheaper than transporting it across the country.[119] However, the transport of imported food cannot always be ensured.

Imports usually arrive in the capitals and ports and remain there so that the urban population may be supplied with food first. In the urban centres food is often sold at subsidized prices, a policy which is meant to promote

117 See Hoff / El-Fadel / Haddadin (2006, 6).

118 See Hummel (2005).

119 See World Water Council (2004, 9).

the urban and thus the industrial and service sectors and so to stimulate development in the peripheral areas, too. This development model is, however, viewed very critically by, among others, Lipton, who presented his urban bias thesis as long ago as the late 1970s.[120] Rural areas in particular may therefore suffer not only from a shortage of staple foods but also from excessively high prices, which are due to the heavy demand and limited supply. Meissner demonstrates this, taking Malawi as his example:

> *"In Malawi maize production dropped by over 33 % in 2001. The strategic grain reserves had been exhausted and maize imports were constrained by transport bottlenecks. As a result, maize prices in some areas had increased by more than 300 % since July 2001."*[121]

Hummel also denounces corruption, clientelism and weak institutions in many developing countries and, if Virtual Water Trade is introduced, sees them as posing one of the gravest threats to the success of the strategy.

She refers to the dangers which would arise if the state had a monopoly on food supplies.[122] In fragile states increased corruption and clientelism are logical consequences. Strategic groups[123] might use resources specifically to buy political support. This in turn might lead to conflicts between political and ethnic groupings. Hummel therefore comments:

> *"The integration of the actors' views is accompanied by politicization of distribution issues. At least some democracy and governance are needed if peaceful negotiating processes are to begin."*[124]

6.5 Social absorptive capacity

6.5.1 Consideration of the socio-cultural environment

When it comes to determining how capable society is of supporting strategic Virtual Water Trade, a wide range of aspects must be taken into account. As already mentioned in Chapter 6.2.1, restructuring the export

120 See Lipton (1977).

121 Meissner (2003, 203).

122 See Hummel (2005).

123 For the definition of strategic groups see, for example, Evers (1999).

124 Hummel (2005, 11).

sector and extensifying agriculture would make workers in the agricultural sector redundant. Depending on the level of development the country concerned has reached, a large proportion of the population may be affected. In sub-Saharan Africa, for example, up to 90 % of the working population is employed in agriculture.[125] In the Middle East (MENA) the proportion is smaller, but there, too, the social effects of Virtual Water Trade would be felt:

> *"Approximately 20 percent of MENA's population is employed in agriculture. Within this context, virtual water being used would force families to migrate to the cities in order to look for alternative income generating modules. This would be hindered by the fact that they are neither well educated nor skilled to compete with their peers in the labour market."*[126]

El-Naser addresses two problem areas in his statement. First, there is the danger of a large proportion of the rural population migrating to the cities to seek alternative income opportunities. But unemployment in the cities is, of course, particularly high in countries where the industrial sector is not yet well developed.[127] Virtual Water Trade could thus become an undesirable pull factor, without the urban centres having the capacities to absorb the newcomers.

A requirement for the sustainable introduction of strategic Virtual Water Trade is, then, the creation of new income opportunities for the rural population. Where possible, this should be done not in the urban centres, but in rural areas or smaller towns so as to avoid any marginalization of rural areas and to promote local economies.

Second, El-Naser points out that the people migrating from rural to urban areas usually lack both the education and the training to compete for jobs in the industrial sector. Unless education policy measures are taken, there will be little chance of developing an industrial sector in rural areas, since there traditional know-how in particular prevails. Nor, according to Hummel, is there necessarily any desire to abandon that know-how:

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125 See FAO Statistical Yearbook 2004: http://www.fao.org/statistics/yearbook/vol_1_1/index_en.asp.

126 El-Naser (2005, 6).

127 See, for example, De Jong / Fawcett (1981).

> *"The change of structures in national and regional economies which is associated with the transformation of trade relations in the concept of virtual water trade poses many challenges for the importing countries. A question that arises concerns the social acceptance of radical changes to local economic structures shifting from agriculture to industrial production and brushing aside patterns of agricultural production that have evolved over the centuries, often handed down from father to son [...]."*[128]

Much the same is pointed out by El-Naser, who questions the possibility of abandoning or reducing agricultural activities in line with strategic Virtual Water Trade, given the traditional political authority of large farming families:

> *"There are other complexities, political and economic, that constrain the MENA countries from applying the concept of virtual water and in reallocating their water from agriculture to other sectors, most importantly the fact that in rural societies old farmer families are by tradition politically influential which will prohibit new polices for water allocation. Agriculture and rural life in village life have historically played central roles in the life, economy and culture of those people."*[129]

On the whole, the emphasis in the debate should be placed on a "balancing of interests".

6.5.2 Consideration of dietary habits

If Virtual Water Trade is to be socially acceptable, it will be necessary to take into account, among other things, the dietary habits, consumption structures and lifestyles of the people in the importing countries. Negative experience in this respect was gained during the Green Revolution, when traditional grain varieties were replaced by new, high-yield varieties, the taste of which was, in some cases, far less attractive. It is important, then, for food imports to be guided by the people's needs.

National and regional Virtual Water Trade poses less of a risk than North-South trade in this respect. The latter has already led to major changes in the consumption patterns of urban elites and also of the broader middle

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128 Hummel (2005, 1).

129 El-Naser (2005, 6).

classes in developing countries. The more these consumption patterns approximate to those of the industrialized countries of the North, the more water will be consumed (since the new products usually consume more water than traditional products), the more the rural population will be marginalized (since they will no longer be able to sell their products) and the more the new agricultural growing patterns will pollute the environment in those countries if they yield to the pressure to adjust.

6.6 Ecological sustainability of Virtual Water Trade

The aim of strategic Virtual Water Trade is to conserve water resources, and this is also meant to benefit the environment. However, adverse effects on the environment are also associated with Virtual Water Trade and positive and negative impacts must therefore be weighed up for an ecological appraisal of the strategy.

6.6.1 Possible synthesis of economic growth and resource consumption

The main question for the developing countries, including the water-scarce among them, is how to achieve economic growth most effectively. Ecological aspects are usually a secondary consideration in this context, which, with the industrialization of those countries on the increase, often results in high consumption or serious pollution of natural resources. During the debate on sustainable development the question of the synthesis of economic growth and ecological sustainability arises – primarily in industrialized countries to begin with. Current discussions pivot on such issues as “dematerialization”[130] and the “decoupling” of economic growth and the consumption of natural resources.[131]

In keeping with this debate, Turton notes that a synthesis of the two poles can be based on the alternative paradigm of Virtual Water Trade (see Fig.

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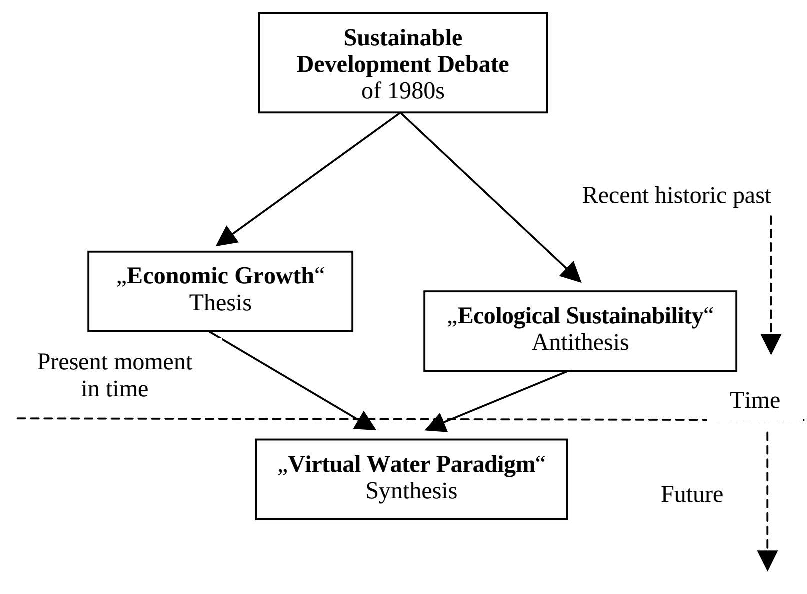
130 See Partzsch / Schepelmann (2005, 2).

131 For the strategy of decoupling economic growth and the consumption of natural resources see, for example, the OECD indicators at http://www.oecd.org/dataoecd/0/52/1933638.pdf.

Figure 10: "Virtual Water Paradigm" Synthesis



Source: Turton (1999, 17)

10).[132] As food production in water-rich countries is not accompanied by the overuse of water resources, according to Turton, Virtual Water Trade is accompanied by the global and national protection of the resource. That this is not so simple is evident from the comments in the next section, in which the ecological risks to which Virtual Water Trade will expose land and water resources in the potential exporting countries are examined.

6.6.2 Ecological risks inherent in Virtual Water Trade

On the basis of the "ecological rucksack", which can be established with the aid of a *Material Flow Analysis* (MFA) for determining global material flows, Partzsch and Schepelmann argue, however, that strategic Virtual

132 See Turton (1999).

Table 1: Most important components of an MFA	
Input side (origin)	
Used national withdrawals	e. g. biomass, fossil fuels, minerals
Unused (“hidden”) national withdrawals	e. g. unused by-products of the harvesting of biomass, timber losses
Imports	e. g. raw materials
Indirect (“hidden”) flows associated with imports	e. g. primary resources, such as virtual water (“ecological rucksack”)
Output side (whereabouts)	
Processed discharge into the environment	e. g. emissions in water and air
Elimination of unused (“hidden”) national withdrawals	e. g. elimination of by-products, excavated earth
Exports	e. g. material for exported goods
Indirect (“hidden”) flows associated with exports	e. g. “hidden” withdrawals of primary resources (“ecological rucksack”)
Source: Partzsch / Schepelmann (2005) based on Eurostat (2001) (abridged and supplemented)	

Water Trade may have, from the ecological viewpoint, far-reaching adverse consequences, primarily in countries exporting virtual water.[133]

The MFA assesses all material flows in individual economies through the various processes from raw materials extraction through production and consumption to waste management.[134] This enables the resource consumption caused to be assigned to each phase of the production and consumption system, and the phases in which efforts should be made to achieve an absolute reduction in resource consumption and in the emission of harmful

133 See Partzsch / Schepelmann (2005).

134 See Bringezu / Moll / Schütz (2002, 17).

substances to be identified. A distinction is made between the following components on the input side (origin) and output side (whereabouts):

The ecological rucksack contains the resources which are consumed in the production of a good, but which no longer have an economic value in the market, since they are no longer contained in the product or only in virtual form. Partzsch and Schepelmann argue that only an integrated analysis of actual and virtual material flows of this kind is an appropriate means of measuring the ecological effects of global trade. In their view the concept of strategic Virtual Water Trade does not therefore go far enough:

> *"A spatial (and sectoral) shift of agricultural production not only affects water withdrawals, but also has an impact on all integrated physical processes. Water is a constituent element of all ecosystems. [...] Dramatic though overuse may be in an individual case, focusing solely on water withdrawals, leads to the total neglect of other aspects, such as the area of land used and pollution due to agriculture. Where one factor is examined in isolation, decisive physical limits and environmental impacts on both the input and the output side may be overlooked."*[135]

A second criticism voiced by Partzsch and Schepelmann is directed against efforts merely to shift water consumption to water-rich countries by means of Virtual Water Trade, without any absolute reduction in water consumption patterns. This argument is countered by advocates of the virtual water strategy by the reply that both the spatial and the sectoral shift of water use enables savings to be made as such, which is the main aim of the strategy. The sectoral shift of water use, away from agriculture to industry, has enormous potential. At national level, then, there is considerable potential for saving resources.

6.6.3 Environmental risks posed by Virtual Water Trade

6.6.3.1 Exporting countries

As Partzsch and Schepelmann see it, the strategy of Virtual Water Trade also fails to go far enough in that it overlooks the fact that intensive agricultural production in the exporting as well as the importing countries

135 Partzsch / Schepelmann (2005, 8 f.).

poses the threat of water resources assumed to be plentiful being overused and of the quality of other resources, too, being adversely affected.[136]

The most glaring example of this is the overuse of groundwater resources in the Ogallala aquifer in the USA. The groundwater level of the aquifer, which is located within the boundaries of the *North Plains Groundwater Conservation District*, is sinking by an annual average of 53 cm and in some areas by as much as 1.5 m.[137] This is due to extensive withdrawals of groundwater for the agricultural sector, the aquifer region being among the most productive locations in the USA for farming and cattle-breeding. Since the late 1990s measures have been taken at the Ogallala aquifer to protect the groundwater. They include more efficient irrigation systems and reducing the areas irrigated.[138] This example shows that a political strategy for introducing Virtual Water Trade must form part of a comprehensive water resource management strategy if it is to be ecologically acceptable and avoids to simply shifting the groundwater problem from one region of the world to another.

Partzsch and Schepelmann call for a full analysis of the possible ecological consequences in the exporting countries. They also include, for example, the requirement that areas used by agriculture should be regarded as "virtually traded land", since here too there is an increased risk of degradation in many countries:

> *"A full analysis of material flows and land use would enable the size of the ecological rucksack and the amount of land used for virtual water trade to be calculated. The danger in shifting resource consumption (and pollution) is that one evil may be replaced by another."*[139]

If, then, the exporting countries in, say, Southern Africa are integrated into a regional Virtual Water Trade strategy, they, too, should give some priority to the protection of the environment as a whole. As Fig. 11 shows, the inappropriate use of pesticides in Africa, for example, is already a serious ecological problem. This must be taken into account if a regional Virtual Water Trade strategy is recommended e. g. for Southern Africa.

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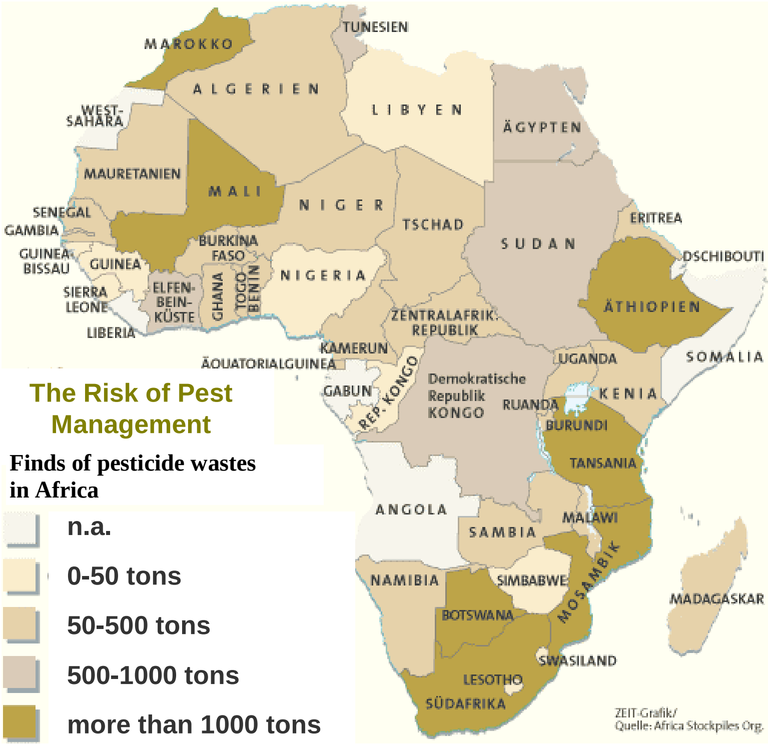
136 See Partzsch / Schepelmann (2005).

137 See http://www.npwd.org/Ogallala.htm.

138 See http://de.wikipedia.org/wiki/Ogallala_Aquifer.

139 Partzsch / Schepelmann (2005, 11).

Figure 11: Pesticide waste found in Africa



Source: http://www.zeit.de/2003/35/U-Altpestizide

The critical comments by Partzsch / Schepelmann make it clear that:

1. water quality issues as well as quantitative issues must be included in the debate on Virtual Water Trade if it is to be comprehensive;

2. water must not be considered in isolation if the ecological sustainability of a strategy is to be assessed, but must be seen as closely associated with land and other issues; and

3. problems connected with the degradation of water quality and land due to Virtual Water Trade will be transferred elsewhere if they are not included in the deliberations from the outset.

Erroneously, the water crisis is often perceived as no more than a quantity crisis. This is particularly true of the debate on Virtual Water Trade. If, however, the question of quality is taken seriously, it becomes clear that ecological farming will have to be the norm globally in the long term for the problems of water and soil pollution to be brought under control.

6.6.3.2 Importing countries

For the importing countries, too, Virtual Water Trade in itself is not a sustainability strategy with which environmental resources would be adequately protected. Although pollution due to agro-chemicals would decrease, it might be replaced by even more serious pollution caused by industrial waste water. Virtual Water Trade as such must not therefore be seen as an environmental protection measure.

6.6.4 Repair and improvement of existing water allocation structures

An important measure that should accompany Virtual Water Trade is therefore the improvement of existing structures and infrastructure systems with a view to conserving local water resources or increasing their productivity. As changing the export sector and diversifying the economy are lengthy processes and as existing agricultural systems cannot and should not be abolished on an *ad hoc* basis, a start should be made, where appropriate, on optimizing existing structures. Hoff, El-Fadel and Haddadin similarly advocate the integration of politically induced Virtual Water Trade and water use policies, since the Virtual Water Trade strategy

> *"[…] cannot be limited to 'taking water away' from farmers, but would have to be complemented by measures to improve water productivity […]."*[140]

140 Hoff / El-Fadel / Haddadin (2006, 3).

Many countries are already running projects or programs geared to improving water allocation and productivity and also improving the coordination of different water users and uses e. g. along a river. Where they do not yet exist, the introduction of Virtual Water Trade in isolation may be counterproductive, as Anthony Allan himself warns,[141] since the scarcity of water may not be seen as a problem by politicians and society and strategies to improve water management may not therefore be introduced:

> *"Because virtual water is economically invisible and politically silent it has the wondrous virtue of making it possible for water policy-makers and managers to cultivate a policy discourse where it can be assumed that there is no national water or food deficit."*[142]

There is already a very wide variety of approaches to improving the management of water both at local and at regional and international level. El-Naser, too, is in favour of full use being made of these approaches because they are socially acceptable and do not force people to give up their way of life.[143]

7 Measures that should accompany Virtual Water Trade

7.1 Is Virtual Water Trade compatible with IWRM?

Integrated Water Resource Management (IWRM) is an internationally acknowledged concept[144] and is currently regarded as the most important strategy for resolving the water crisis. The authors of this study believe that – where it is pursued – the Virtual Water Trade strategy should accompany the IWRM strategy or become part of it.

The aim of IWRM is to work out, in a participatory process, solutions which are acceptable to all users (stakeholders) and for all uses and take equal account of differing interests – particularly among the various sectors. The most important components are shown in Table 2:

141 Interview on 30 September 2005.

142 Allan (2003c, 4).

143 See El-Naser (2005).

144 For the Dublin principles see http://www.gwpforum.org/servlet/PSP?iNodeID=1345.

Table 2: Most important components of IWRM
Managing water resources at the basin or watershed scale. This includes integrating land and water, upstream and downstream, groundwater, surface water, and coastal resources.
Optimizing supply. This involves conducting assessments of surface and groundwater supplies, analyzing water balances, adopting wastewater reuse, and evaluating the environmental impacts of distribution and use options.
Managing demand. This includes adopting cost recovery policies, utilizing water-efficient technologies, and establishing decentralized water management authorities.
Providing equitable access to water resources through participatory and transparent governance and management. This may include support for effective water users' associations, involvement of marginalized groups, and consideration of gender issues.
Establishing improved and integrated policy, regulatory, and institutional frameworks. Examples are implementation of the polluter-pays principle, water quality norms and standards, and market-based regulatory mechanisms.
Utilizing an inter-sectoral approach to decision-making, where authority for managing water resources is employed responsibly and stakeholders have a share in the process.
Source: http://www.usaid.gov/our_work/environment/water/what_is_iwrm.html

Such authors as Hummel or Youkhana and Laube detect a problem in the incorporation of strategic Virtual Water Trade into the concept of integrated water resource management:[145] the Virtual Water Trade strategy calls for the decision on restricting water use to be taken by central government and enshrined institutionally and in law. The idea underlying IWRM, however, is that water management should be increasingly decentralized and taken over by all the stakeholders concerned in keeping with

145 See Hummel (2005); Youkhana / Laube (2006).

the principle of subsidiarity. In many countries reforms and measures are already being implemented in accordance with IWRM. Youkhana and Laube therefore maintain:

> *"while there is no desire here to evaluate these reform processes, it has yet to be determined how far the strategic introduction of 'virtual water trade' as a national adjustment strategy is inconsistent with the idea of decentralizing decision-making structures and accountabilities."*[146]

Neubert and Horlemann recommend the establishment of water master plans at national and regional level while IWRM is being introduced.[147] Virtual Water Trade could be integrated into these master plans as an element where absolute hydrological water scarcity prevails or where planned water infrastructure projects identified as being unsustainable can be avoided by means of increased Virtual Water Trade. Here again, however, it is important for there to be prior negotiations with stakeholders so that interests may be reconciled and Virtual Water Trade discussed as an option and introduced if appropriate. Virtual Water Trade may also be compatible with IWRM where particularly water-intensive crops are imported rather than being grown in agro-ecologically unsuitable regions. This strategy resembles the approach adopted by South Africa, which, as mentioned above, has passed legislation to this effect.

Virtual Water Trade tends to be inconsistent with the idea of decentralizing water policies and, for this and other reasons, is not simply compatible with IWRM. However, it might be compatible with IWRM where other resource management strategies fail and absolute hydrological water scarcity exerts pressure that cannot otherwise be averted. Provided that the change to a strategy of this kind is agreed with the stakeholders, the concept can widen the range of possible solutions.

7.2 Prices and tariffs for water and its supply

As already discussed in Chapter 5.1, Virtual Water Trade would increase automatically if water pricing was introduced, and this market-oriented

146 Youkhana / Laube (2006, 8). This question was also discussed at length at the DIE workshop on 7 December 2005.

147 See Neubert / Horlemann (2005).

development would be much better in many respects than the introduction of Virtual Water Trade by regulatory means. However, Brüntrup argues at length that in global agricultural trade water has yet to be regarded as a factor of production equal to capital, land and labour and, therefore, as a comparative advantage. He also maintains that Virtual Water Trade becomes invalid as a political strategy if this trend is reversed. Where, then, water is included in the economic valuation of a product as a factor of production, trade may automatically evolve in keeping with comparative cost advantages until water-rich countries and countries using water efficiently emerge as leading food exporters.[148]

There is a general consensus among professionals that water-pricing is an appropriate means of achieving the more sparing use of this scarce resource. This is true both of prices for the withdrawal and use of water and of tariffs for its supply or purification, whether for domestic use or for use in industry and agriculture. As by far the largest proportion of water resources is consumed in irrigated agriculture, charging prices for irrigation water is an important step towards sustainable resource management.[149]

It is thus particularly advisable for countries suffering from water scarcity to introduce water prices as a means of controlling demand.[150] Politically induced Virtual Water Trade should not undermine or replace such water pricing policies, but be used, at most, where the introduction of appropriate prices is not possible or not sufficient. Among others, Mondoka and Kampata argue that, when water prices are introduced, it should be ensured that they are adapted to social conditions so as not to impose an undue financial burden on poor population groups:

> *"However when considering small-scale farmers who have no significant influence on the type of water delivery system they use it would be unfair to raise prices because it would not improve efficiency and may actually lead to economic distress."*[151]

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148 See Brüntrup (2005).

149 See, for example, Tsur et al. (2004).

150 For an overview of various approaches to the pricing of water see, for example, Agudelo (2001); Johansson (2000); Tsur et al. (2004).

151 Mondoka / Kampata (2000, 6).

Particularly against the background of the debate on water as a human right and to avoid social unrest (as in Bolivia, for example), Virtual Water Trade might be seen as a means of helping to achieve some control over the demand for water. Here again, however, it must be realized that, as virtual water imported in the form of food cannot be disposed of free of charge, the social costs must again be weighed up or compensated by other means.

7.3 General abolition of subsidies

If the Virtual Water Trade strategy is to be implemented properly, existing subsidization of agriculture and water supplies must be abolished where they are inconsistent with sustainable farming. Such reductions should be made before or during the promotion of Virtual Water Trade. The two most relevant subsidies and the difficulties for Virtual Water Trade possibly associated with them are briefly considered in the following.

7.3.1 Agricultural subsidies

From a development point of view Virtual Water Trade is especially problematical when it is based on existing agricultural subsidies paid by the major exporters, such as the European Union and the USA. The familiar problems then arise: the destruction of domestic food markets and the loss of the opportunity for water-rich countries – and thus potential food exporters – to hold their own in regional markets in the South. As Neubert points out, these countries may then come under pressure to subsidize their own agricultural sectors.[152] At worst, they could do this by subsidizing water for irrigated agriculture. This would again thwart efforts to charge for water even in countries better endowed with water.

Even proponents of strategic Virtual Water Trade should therefore recognize how important it is to reduce or abolish these payments towards the economic development of many poor countries. The potential large exporters of virtual water should press ahead with the abolition of agricultural subsidies. Even if this restricts the amount of virtual water some

152 See Neubert (2004).

countries are able to import, the disadvantage of the distortion of competition leading to the unfair distribution of revenues to the benefit of the industrialized countries is far more serious.

Subsidies in water-scarce developing countries used to promote agriculture may result in inadequate account being taken of water scarcity. Government grants for fertilizers, for example, may also lead to an increase in the growing of water-intensive products and so to increased water consumption. It therefore needs to be considered precisely which, when and where regulatory mechanisms that control the demand for water, however indirectly, should be used so that producers are given the right incentives.[153]

7.3.2 Water price subsidies

In many developing countries the water sector is heavily subsidized. Even in water-scarce countries this subsidization often reflects political dependencies (as in Israel, for example). In many cases, however, the subsidies are not used for any specific purpose, but cover, for example, general water prices and, in agriculture, irrigation equipment and other infrastructure. This results in the subsidies not only benefiting the poor but also promoting activities in agriculture which are unsustainable and use water inefficiently.

Parallel to the introduction of strategic Virtual Water Trade, then, such general subsidies should be converted – in residential water management – into direct subsidies to the poor, and the participation of the private sector should be given greater encouragement.[154] Alternatively, the funds could be purposefully invested – in the case of agriculture – in measures aimed at finding ways to use water more efficiently, or unused funds could be spent on the import of virtual water. Even in water-rich countries subsidies should be used for a specific purpose or abolished.

153 See World Water Council (2004, 15).

154 See, for example, BMZ at http://www.bmz.de/de/service/infothek/fach/spezial/spezial036/a33.html.

7.4 Awareness-building and changing patterns of consumption

It is not only population growth that is leading to rising demand for food, but also the fact that the economic strength of such large countries as China and, with it, incomes are increasing. The developing and newly industrializing countries in particular enjoy, after all, considerable income elasticity, and almost all the increase in incomes is spent on food. Once the need for staple foodstuffs is met, demand turns increasingly to processed agricultural products and semi-luxuries.[155] On the whole, this eventually leads to increased water consumption. In addition huge savings effects could be expected if the consumption patterns of the urban population and of the whole population of industrialized countries changed, and field vegetables and cereals were again consumed rather than meat and gourmet vegetables. The "water footprint", which was presented in Chapter 4.1.2, can reveal how much water, or virtual water, is consumed by a country or individual and can thus be used as a yardstick for consumption patterns. On this basis, it is possible to take measures geared to informing and increasing the awareness of the people. Acceptance in society of such strategies for the better management of natural resources as Virtual Water Trade might then increase and eventually reduce political costs.[156] Awareness-building measures will be needed in both exporting and importing countries if supply as well as demand is to change.

8 Identification of countries that qualify for Virtual Water Trade

Finally, now that the opportunities, risks and areas of priority action associated with the political strategy of Virtual Water Trade have been listed, it must be asked for which countries and regions the strategy may be interesting and appropriate. Anthony Allan initially designed the concept for the countries of the Middle East and North Africa. Other authors[157] have applied it to Southern Africa and the SADC region, for example.

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155 See Schug / Léon / Gravert (1996).

156 See World Water Council (2004, 17).

157 See Earle / Turton (2003); Malzbender (2005); Turton (1999; 2001).

8.1 Possible indicators

On the basis of indicators yet to be defined, it would be conceivable to identify groups of countries which might establish, for example, a regional political strategy for examining Virtual Water Trade for themselves. A number of possible indicators[158] are presented in the following.

1. The availability of water
2. The economy's level of development and degree of diversification
3. Social adaptive capacity
4. The percentage of agricultural unemployment to total unemployment
5. The water use efficiency of the economy
6. The relationship between the implementing authority and the agricultural sector and/or the rural population
7. The current percentage of food requirements produced domestically
8. The degree to which the implementing authority encourages / discourages stakeholder representation
9. The account taken of environmental flows through the availability of water per unit of exported product
10. The water storage capacity per unit of exported product

8.1.1 Indicator 1: The availability of water

The most important indicator or index, and also the most difficult to define, is a country‘s water sufficiency or water scarcity. According to the United Nations Food and Agricultural Organization (FAO) a country is deemed to be water-scarce when it has less than 1000 m^3 of renewable water resources per capita per annum.[159] Yet there is still no generally accepted definition of multi-dimensionally understood water scarcity that includes more than this factor. A debate is currently being conducted on

158 The list of these indicators essentially corresponds to that compiled by the World Water Council (2004).

159 See www.thewaterpage.com.

what factors jointly constitute water scarcity and in what form they can be combined to produce an index.

The aggregation of various factors into an indicator has already been undertaken by several authors using different approaches, examples being Falkenmark / Lundquist / Widstrand, Ohlsson and Gleick.[160] The Falkenmark index, for instance, comprises the water requirements of households, agriculture, industry, energy and the environment and calculates from the result the threshold value for a country's water scarcity. Ohlsson modifies the Falkenmark index by including society's adaptive capacity, i. e. its ability to react to water scarcity with economic and technological measures.

Another approach is adopted in the *Water Poverty Index* (WPI),[161] which combines the data on existing water resources, the population's access to water, the population's capacity, water uses and the environment:

> *"Such an index makes it possible to rank countries and communities within countries taking into account both physical and socioeconomic factors associated with water scarcity. This enables national and international organizations concerned with water provision and management to monitor both the resources available and the socio-economic factors which impact on access and use of those resources."*[162]

Warner and Kluge / Liehr also demonstrate that water scarcity should not only be measured in physical terms, but has various causes, which in turn require different measures to combat them (see Table 3).[163] Thus water scarcity is not only reflected in its physical absence: it may also be due to technical, economic, social and politically induced factors. The question is, then, how these various factors can be aggregated appropriately to form an indicator or whether they should be split into different indicators.

In general, the most serious problem is obtaining reliable data with which to determine the availability of water in a country. This problem grows

160 See Falkenmark / Lundquist / Widstrand (1989); Ohlsson (1998; 1999); Gleick (2002). A very good overview of various approaches to determining water poverty is provided by Rijsberman (2004).

161 See Lawrence / Meigh / Sullivan (2003).

162 Lawrence / Meigh / Sullivan (2003, 3).

163 See Warner (2003); Kluge / Liehr (2005).

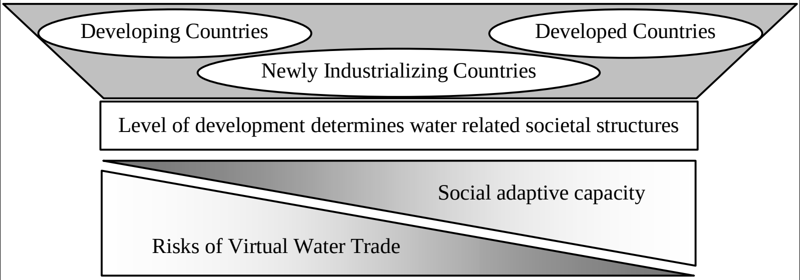
Table 3: Types of water scarcity	
Type of water scarcity	*Limiting factor*
Absolute	Physical absence
Technical	Technological (and economic) limits to generation
Economic	Macroeconomic policy decisions
Social	Absence of social ingenuity, institutional / political maturity
Induced	Political strategy, exploitation of resources
Source: Warner (2003, 129), abridged	

with the number of factors to be reflected in the indicator to enable a comprehensive statement to be made on physical, social, economic, political and ecological potential or deficiencies.

If only the indicator of water scarcity is considered, introducing Virtual Water Trade makes sense primarily in the case of scarcity that exists hydrologically, i. e. when no other approaches to water conservation are available. As, however, the various forms of water scarcity in fact merge, water is wasted, for example, despite hydrological scarcity, as in Jordan. Where water scarcity is politically induced, there may be little hope of making Virtual Water Trade popular with the political decision-makers.

There is thus nothing to lead the authors of this study to change their fundamental statement that, where possible, all sustainable resource management approaches should be explored before Virtual Water Trade is included as a political strategy. This is particularly true when water scarcity is not absolute but due to institutional, economic or technological shortcomings.

Figure 12: Potential of society to adapt in water-scarce countries



Source: Kluge / Liehr (2005, 10)

8.1.2 Indicator 2: The economy's level of development and degree of diversification

Kluge and Liehr attempt an initial typification of water-scarce countries by subdividing them according to their social and economic adjustment potential. They propose that the partially water-related societal structures of the *Water Poverty Index* (access, use, capacity) should either be removed from the WPI (absolute procedure) or examined in relation to the total value (relative procedure).[164]

They generally assume that an indicator could be formed roughly along the lines of the subdivision into developing, newly industrializing and industrialized countries, since the ability to introduce Virtual Water Trade sustainably rises with level of development (see Fig. 12):

> *"Along the axis from developing countries through newly industrializing countries to developed countries conclusions can already be drawn on their specific adjustment potential and so on the extent to which the potential for shaping trade in virtual water can be tapped."*[165]

The economy's degree of diversification can be determined by calculating the proportions of total gross national product for which the various sectors of the economy – agriculture, industry and services – account. These

164 See Kluge / Liehr (2005, 6).

165 Kluge / Liehr (2005, 13).

data can be derived, for example, from UNDP's annual "Human Development Report".[166] Kluge und Liehr maintain:

> *"For a society whose economic capacity is limited to agriculture and so to the primary sector a long process is needed before, through the development of the secondary and tertiary sectors, forms of water use with a value added that easily exceeds that generated by strategies based solely on agriculture can be developed."*[167]

The indicator of the economy's level of development and diversification can, however, do no more than point to a rough line of approach. Kluge and Liehr therefore contend that an accurate examination of appropriate countries or societies requires other, more specific indicators that again illuminate in detail the social, economic, agricultural and institutional / legal sectors.

8.1.3 Indicator 3: Social adaptive capacity

The social adaptive capacity of a society should be a further important indicator. It should be extremely high, and the population should accordingly be extremely flexible when the introduction of Virtual Water Trade is imminent. Social adaptive capacity is in turn composed of various sub-indicators. As Kluge and Liehr point it:

> *"Indicators for the social sector must reflect an appraisal of the social environment and thus the present state and the trend in matters of social flexibility with respect to water-related uses and employment relationships."*[168]

Such factors as level of education, literacy rate, rates of migration and degree of urbanization may have an influence in this respect. Existing data, such as the Gini coefficient,[169] the *Water Poverty Index* (WPI)[170] and the *Human Development Index* (HDI)[171] could also be consulted.

166 See hdr.undp.org.

167 Kluge / Liehr (2005, 11).

168 ibid.

169 See de.wikipedia.org/wiki/Gini-Koeffizient.

170 See Lawrence / Meigh / Sullivan (2003).

171 See hdr.undp.org.

Greater difficulties are encountered in determining sub-indicators on cultural circumstances, such as traditional family structures, norms, value systems and gender aspects. They can hardly be measured in quantitative terms and should be included as qualitative factors.

8.1.4 Indicator 4: The percentage of agricultural unemployment to total unemployment

An important indicator proposed by the *World Water Council* is the percentage of agricultural unemployment to total unemployment in a country.[172] In countries where the percentage is very high the introduction of strategic Virtual Water Trade poses a major social risk, since unemployment in this sector could rise significantly.

Measures to promote agriculture in such countries should be considered a priority. As Schug / Léon / Gravert point out, it is particularly important to support labour-intensive agricultural activities.[173] In much the same way as Kluge and Liehr have argued, this indicator may also follow the subdivision into developing, newly industrializing and developed countries relatively closely, since the poorest countries usually have a high percentage of unemployed in the agricultural sector, which declines as the level of development rises.

8.1.5 Indicator 5: Water use efficiency in agriculture

Water use efficiency can be used as a further indicator for gauging how far a country might benefit from strategic Virtual Water Trade. In this case it would have to be decided whether Virtual Water Trade or an improvement of the infrastructure or irrigation systems would be a suitable solution for coping with water scarcity.

Where a water-rich country uses water very efficiently in the production of goods, there would be relatively little objection to its involvement in a regional strategy as an exporter of virtual water, for example. If a water-rich country uses water inefficiently when producing goods, its involve-

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172 See World Water Council (2004).

173 See Schug / Léon / Gravert (1996).

ment would not be possible unless further support measures were taken to protect national water resources. Water-scarce countries may similarly use water efficiently in the production process, but its water resources may still be at risk. If agriculture is a relatively stable sector, recommendations for the reorientation or replacement of agricultural products might be made.

8.1.6 Indicator 6: The relationship between the implementing authority and the agricultural sector and / or the rural population

Another important indicator for determining the potential of strategic Virtual Water Trade is the relationship between the government or political decision-makers and the rural population. This indicator is relevant because Virtual Water Trade can be introduced in a socially tolerable way only if it is accompanied by appropriate measures to cushion the possible risks to the rural population.

Here again, the development of rural areas is very important. According to the World Bank, their development is based on at least two pillars: first the "good employment multiplier", especially in the non-agricultural sphere, which is a measure for all indirect jobs created for every direct job in the certain sector. And second the "training effect" of non-agricultural employment, because the latter allows a rural family to diversify their forms of income generation and also can lead to urban skills.[174]

8.1.7 Indicator 7: The current percentage of food requirements produced domestically

Another indicator proposed by the *World Water Council* is the percentage of food requirements met by local agricultural production. This indicator says nothing, however, about the water-efficiency of production in a country or whether it is already overusing its resources. It can therefore be seen as linked to the water availability indicator.

174 See World Bank (2003).

If the country is water-scarce and meets a large percentage of its food requirements from local production, Virtual Water Trade may be appropriate as a political strategy. But if a large percentage of its food requirements is already being imported, the political implementation of the strategy may no longer be necessary.

8.1.8 Indicator 8: The degree to which the implementing authority encourages / discourages stakeholder representation

As already explained in Chapter 7.1, strategic Virtual Water Trade must be introduced within a framework that is appropriate to the integrated water resource management approaches. Only then is such a strategy acceptable. An important indicator of a country's potential for implementing the strategy should therefore be whether the competent authority generally encourages the participation of the relevant stakeholders in its area of responsibility.

The basis here might be, for example, the World Bank's governance indicator, since voice and accountability have a part to play in it as one of six dimensions.[175] In the implementation of a strategy which may have major impacts on society, the economy and the environment, as many interest groups and representatives of affected sections of the population as possible should be involved so as to minimize the risks as far as possible.

8.1.9 Indicator 9: The account taken of environmental flows through the availability of water per unit of exported product

The *World Water Council* (2004) proposes that environmental flows should be included in another indicator through the division of a country's total water availability by units of exported product.[176] The lower the result, the less water the country has and the more it should refrain from exporting virtual water. Environmental flows denote the quantity of water

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175 See "Governance Indicators 1994–2004" at http://www.worldbank.org/wbi/governance/govdata/.

176 It is not stated here whether only agricultural export products are concerned.

needed to guarantee the existence of a river basin in an ecologically sustainable way. Water resources already present or released into the river are included:

> *"Environmental flows are the water that is left in a river ecosystem, or released into it, for the specific purpose of managing the condition of that ecosystem."*[177]

The aim is to measure the influence which the export of goods has on the availability of water in a country and thus on the ecological balance of a river basin. The result is an aggregate indicator of virtual water exports and their influence on the environment.

8.1.10 Indicator 10: The country's water storage capacity per unit of exported product

A further indicator proposed by the *World Water Council* is formed from a country's capacity to store water (e. g. through the construction of dams) related to the quantity of exported products. It can be shown in this way what influence trade in virtual water may have on the food security of the population, since in arid and semi-arid areas in particular the temporal and quantitative availability of water is a limiting factor for agriculture and so for the security of food supply.

8.2 Grouping candidate countries

With the aid of suitable indicators, it would be possible to identify countries that might potentially be considered for Virtual Water Trade and to subdivide them, for example, into exporters and importers or by regions. However, the indicators could also be applied at national level if a country wanted to increase its internal Virtual Water Trade.

From the development point of view it can first be said that the potential of a water-scarce country for stepping up Virtual Water Trade rises with its level of development (as measured with the HDI, for instance), since the good performance of the economy and policy and the adaptive capacity of the (rural) population are seen as the fundamental premises for effective

177 Davis / Hirji (2003, 11).

Virtual Water Trade. The *Water Poverty Index* might at first be used as the basis for the initial identification and grouping of potential countries.

An overall view of all the indicators should first be taken at local, and then at national and regional level to make it clear what kind of Virtual Water Trade would be appropriate in each case. Where a country has both water-scarce and water-rich regions, internal Virtual Water Trade may in itself solve much of the problem of water scarcity without having the enormous negative side-effects described in the study.

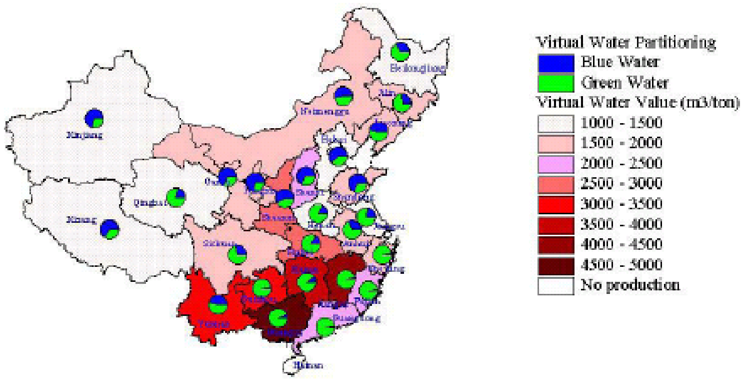
Yet there is again a need to clarify the extent to which social adaptive capacities exist in the water-scarce areas, whether there is likely to be any potential for increasing production in the water-rich regions, etc. If the analysis of the indicators reveals that neighbouring countries have similar potential, a regional strategy in favour of South-South trade may be appropriate. A number of examples will be discussed in the following.

8.2.1 Internal Virtual Water Trade: the case of China

Obuobie, Gachanja and Dörr have shown in their study how differently the various regions of China use their green and blue water resources.[178] The use of green water, for example, varies between 83 % in the province of Henan and 32 % in the province of Shandong (see Fig. 15). To protect blue water resources in the water-scarce North, the potential of the provinces growing food in rain-fed farming could be tapped to a greater extent and the agricultural products traded locally, i. e. among the provinces. This would also accommodate the credo of self-sufficiency in food, which the Chinese government has been preaching since the 1960s.

178 See Obuobie / Gachanja / Dörr (2005).

Figure 13: Shares of green and blue water resources in the virtual water content of wheat in China, 1999



Source: http://www.nideco.ethz.ch/news/past_events/colloquium_2003/Liu_Presentation.pdf

8.2.2 Regional Virtual Water Trade: options for the SADC region

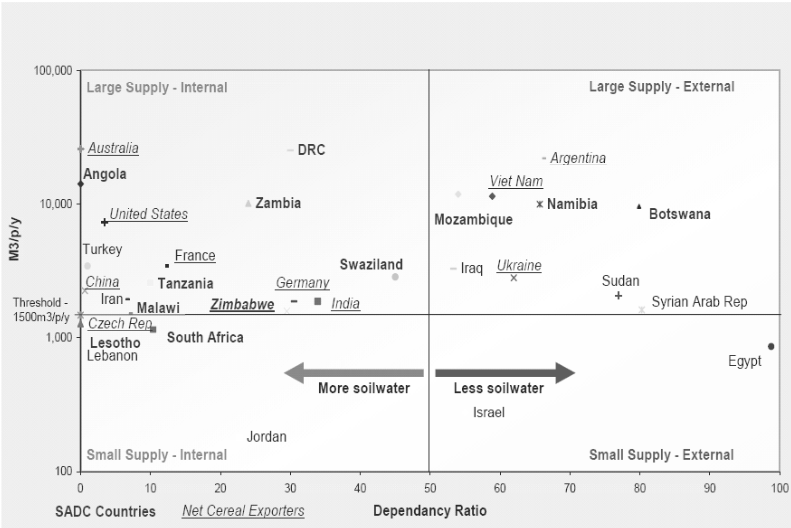
Earle and Turton have examined a further option for the grouping of countries for Virtual Water Trade and applied it to the SADC region as an example.[179] From existing water resources and dependence on them it can be determined in which countries there is still potential for the export of virtual water and which countries might resort to strategic Virtual Water Trade as importers.

This subdivision produces four categories of countries (see Fig. 14):

1. *Large supply – internal*: Besides a large supply of water, these countries have a high degree of geographical control over their water resources. Sufficient soil water, too, is available. This category also includes such large grain exporters of the SADC region as Zimbabwe.

179 See Earle / Turton (2003).

Figure 14: Water resources and dependence of various grain importers and exporters



Source: Earle / Turton (2003, 186)

2. *Large supply – external*: Although the countries in this category have an adequate supply, they are limited in their decisions by the claims of other users up- and downstream. However, some of these countries also have sufficient rainfall to produce grain, which could possibly be exported, Mozambique being an example.

3. *Small supply – internal*: Although these countries have a relatively small supply of water, many maintain an agricultural sector based on domestic water resources. Rainfall is regionally distributed and even enables these countries to export grain.

4. *Small supply – external*: These countries are in the most vulnerable position, since not only do they have a small supply of water, but it

> also comes from a neighbouring country. They therefore need both political weight and economic strength to obtain enough water.[180]

In addition, Earle and Turton divide the countries of the SADC region into "pivotal states" and "impacted states" depending on their influence on a river basin.

> *"The significance of these concepts is that they explain the nature of the political and economic relationships that exist between various riparian states in international river basins. The possible future trade in Virtual Water is affected by these existing hydro-political factors. For example, Mozambique is a potential virtual water exporter, by virtue of its relatively favourable natural precipitation pattern. In reality however, Mozambique is an Impacted State with relatively little room for manoeuvre, being politically and economically dominated by South Africa and Zimbabwe, both Pivotal States, and both being upstream riparians to Mozambique on various international river basins."*[181]

Earle and Turton point out that, although natural conditions mean that there is potential for regional Virtual Water Trade, political instability and economic dependencies are obstacles to its introduction. This example, too, makes it clear that an integrated view must be taken of various indicators in an appropriate grouping of potential beneficiaries of Virtual Water Trade.

8.2.3 Virtual Water Trade and the MENA countries

Allan assumes that Virtual Water Trade is primarily suitable as a political strategy for the countries of the Middle East and North Africa, since they are, firstly, particularly water-scarce and, secondly, able to generate sufficient foreign exchange in the form of revenue from oil exports to finance virtual water imports. A grouping in this case would thus be effected among the water-scarce countries on the basis of economic potency. As the whole region suffers from water scarcity, a regional strategy of Virtual Water Trade makes little sense. The main aim here, then, is to protect the region's water resources, but without considering options for South-South trade with neighbouring countries.

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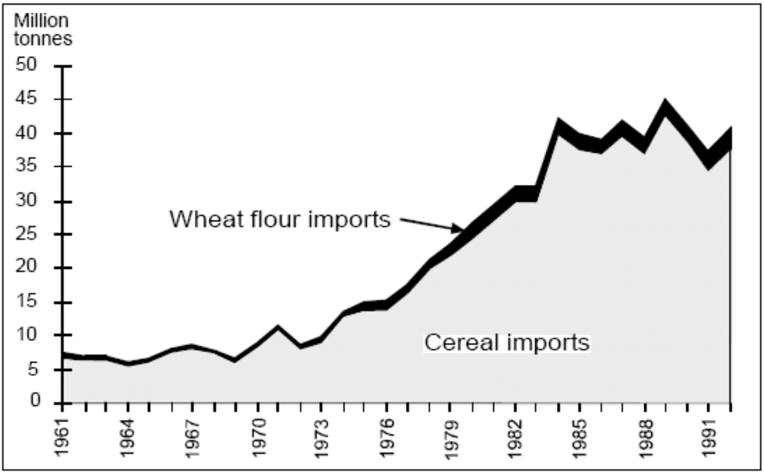
180 See Earle / Turton (2003, 186).

181 Earle / Turton (2003, 187).

Figure 15: Imports of grain and wheat flour by the Middle East (1961-1992)



Source: Jobson (1999, 3)

It can indeed be seen that imports of grain and wheat flour in the Middle East grew steadily from 1961 to 1993 (see Fig. 13), which Allan puts down to the increasing water scarcity of those countries and the consequent production of less food domestically.[182]

Allan nonetheless considers the political introduction of Virtual Water Trade to be difficult because political factors prevent an open discourse on water scarcity and on a further reduction of agricultural activities (see Chapter 6.3.4). Virtual Water Trade may, however, help to prevent social and political conflicts from occurring when water prices are introduced, as Allan shows with reference to Israel, which charges 40 % of the provision costs for irrigation:

182 See Allan (1997), but also Schiffler (1998). Such authors as Brüntrup (2005) argue, however, that globally no more than an insignificant portion of agricultural trade takes place on grounds of water poverty.

> *"Other countries in the region, including Jordan, Tunisia and Morocco, are gradually following Israel's example. Importing virtual water may give them a period of grace for the difficult changeover and also help to prevent political tensions."*[183]

9 Need for research and debate

Although the research community has taken a greater interest in the concept of Virtual Water Trade for some years, quite a few questions remain unanswered, making it clear that more research is needed. A number of issues will be examined below.

9.1 Concept of global and local water conservation

Even among water experts the concept of global water conservation is often accepted uncritically. As already remarked elsewhere, a set of unsettled circumstances is accepted as the truth in the debate without further examination.

This concerns in particular the calculation of the consumption of water by agriculture and the resulting, assumed absolute saving if the crop concerned was grown elsewhere. In principle, the water in agriculture that is transpired through both the soil and the crop plant is, however, reusable, since the global water cycle results in its landing back on the soil a few days later as precipitation, though at another place. Although water can thus be saved locally, the same cannot be said of the global level. Added factors are "return flow" and drainage water, which, though representing a loss at irrigation system level, can be largely reused at river level. It is therefore far more difficult to use water efficiently in relation to the whole course of a river than if only the irrigation system is considered. How these thoughts impact on the concept of Virtual Water Trade and how far they call it into questions should be discussed in greater depth in the future.

183 Allan, year of publication not given, at: http://www.unesco.ch/actual-content/new/virtualwater/dossier_virtuelles_wasser_frame.htm.

9.2 Virtual water content of an agricultural product

There is also a need for research into the quantification of the virtual water content of a product. For one thing, there is still no general agreement on whether the virtual water content should be measured on the basis of the water actually used in its production or of the amount of water saved in the importing country. Each view makes sense in its own way. If the content is determined by the amount of water used during production, it can be seen what the implications – e. g. for the environment – are on the exporter's side. This defining quantity is particularly relevant in the measurement of the ecological rucksack of an agricultural product.

Conversely, it makes just as much sense to measure the virtual water content on the basis of the quantity of water saved by the importer of the agricultural product or the quantity which the country would have needed to produce the product itself. This figure is important for the potential importer when deciding whether or not the introduction of Virtual Water Trade is appropriate as a political strategy and how much water would then be available for other possible uses.

It is also relevant in this context to make a distinction in the measurement between green and blue water resources, since, as has been explained above, not every form of water is available for an alternative purpose. Here again, then, research is needed to enable all the potential of Virtual Water Trade for a country or region to be determined.

9.3 Identification of suitable indicators

The above list of indicators that can be used to determine potential beneficiaries of the strategy of Virtual Water Trade is no more than an initial overview and makes no claim to be complete. The very fact that implementing the strategy has an influence not only on agricultural production but also on the economy, the environment and society in general makes it a major challenge to formulate indicators that are, relatively speaking, generally valid.

This in particular poses difficulties, since, on the one hand, the "water scarcity" of a country, as described under Chapter 8.1, has many causes requiring different solutions. On the other hand, the decisions on whether and to what extent agricultural activities are undertaken are determined by a wide variety of factors in the various countries. Thus in some countries, such as those of sub-Saharan Africa, the agricultural sector is important for combating poverty and safeguarding the food situation, whereas in Middle Eastern countries the reasons tend to be political, since a few large farmers have considerable political influence in those countries.

When it comes to formulating possible indicators, it is therefore necessary to paint as complete a picture of a country as possible and to cover all the relevant factors, and this for both potential importers of virtual water and potential exporters. So far, however, the implications of Virtual Water Trade have been examined in strictly sectoral terms: the researchers have yet to propose much in the way of an integrated approach.

10 Options for development cooperation and résumé

10.1 Options for development cooperation

An important question for development cooperation is how donor countries can and should involve themselves in the debate on the concept of Virtual Water Trade. What is clear is that Virtual Water Trade should only ever be one option for a country, one which should initially be as specific as possible, i. e. geared to individual elements, such as the substitution of a number of crops at certain locations. This might result in restrictions on the growing of certain crops.

The concept of Virtual Water Trade should never be implemented radically by countries and regions, always cautiously and in the framework of IWRM and a good water policy. A great deal of time is needed especially to enable the conditions for successful Virtual Water Trade, as presented in this study, to evolve gradually. Development cooperation might contribute advice and funds for an established strategy of this kind and for the creation of the institutions and infrastructure that will be needed. This would be generally beneficial and might almost incidentally make a major contribution to the long-term successful implementation of the Virtual Water Trade strategy.

The authors of this study believe there also to be various, more direct ways in which the donors might contribute:

1. *Research / identification of indicators:* As pointed out above, there is still a considerable need for research aimed at identifying indicators and eventually the countries or groups of countries for which Virtual Water Trade might be appropriate and less risky. What is needed here is further cooperation among the various groups conducting research on Virtual Water Trade, a start on which has been made at the *International Expert Meetings on Virtual Water Trade*. The greater involvement of political decision-makers and civil society groups might be considered with a view to transferring the concept from the academic to the practical level.

2. *Collection of data:* Data on these indicators collected internationally should be assembled for the continued debate. The various donor and recipient countries might cooperate in this, since there are many data bases existing independently from one another that might, if brought together, produce some valuable findings on the practicability of the Virtual Water Trade strategy.

3. *Advice / possible implementation in programs:* Where a country wishes to implement the Virtual Water Trade strategy politically, international development partners can provide advice on the concept or its appropriate institutionalization and on the minimization of risks.

4. *Organization / advice for regional meetings:* If Virtual Water Trade is to be introduced at regional level and, ideally, help to promote South-South trade, development cooperation institutions could arrange initial regional meetings at which joint strategies might be established. International experts on the subject might attend and present the findings of past research.

5. *International agreements:* In his statement El-Naser calls for a UN resolution on the fair introduction of global Virtual Water Trade.[184] Countries that became more dependent on the world market prices of food as a result of the strategy being implemented would be protected by this resolution. This might minimize political objections – especially from Middle Eastern countries. The donor community could stand up for a resolution of this kind.

184 See El-Naser (2005).

6. *Supporting awareness-building:* On the basis of the water footprint more action might be taken to increase awareness especially in the industrialized countries, but also in the water-scarce developing and newly industrializing countries. Water resources can also be saved globally and Virtual Water Trade influenced positively and indirectly by a change in consumption patterns. In this respect, the donor community might encourage (financially) civil society groups such as NGOs to carry out the campaigns on the issue of water scarcity.

7. *Fair water prices:* Finally, the donor community can do even more to back the introduction of appropriate prices for water and its provision, which would, after all, bring about slow development in the countries concerned in the same direction as Virtual Water Trade is trying to take: the more sparing use of water.

10.2 Résumé: Potential and risks associated with Virtual Water Trade

It has been shown that at local, national and regional level in particular there is considerable potential for saving water resources by exporting food from water-rich countries to water-scarce countries or producing and trading it within a country along the line of water availability. Currently, however, the concept of Virtual Water Trade is being discussed almost entirely in terms of international trade along the North-South axis.

For most developing countries and for all very poor countries, however, this strategy is completely impracticable because of their economically weak position. Regardless of whether the prices of the food traded are subsidized, appropriate foreign exchange must be available to finance virtual water imports. A country's economic strength and its level of development thus determine whether Virtual Water Trade is at all feasible.

An added factor is that in most developing countries the expected negative effects on growth prospects, social integrity and political independence would easily outweigh the positive effects.

The strategy thus tends to be attractive only to countries affected by absolute water scarcity which are on the way to industrialization and have high foreign exchange revenues, as is true of the countries of the Middle East and North Africa and – when it comes to internal Virtual Water Trade among water rich and water scarce localities – of some anchor countries. As has been shown, there is also less risk of negative social effects in economically stronger countries. The adaptive capacity of society generally rises with a country's level of development, since the agricultural sector then wanes in importance and smaller sections of the population are affected by a reduction in agricultural production. Socio-economic conditions therefore improve roughly along the axis from developing countries through newly industrializing and anchor countries to industrialized countries.

It is the least developed countries (LDCs) that suffer most from food shortages, and water shortages play a subordinate role in their national policies. In these countries developing the agricultural sector and increasing agricultural production – by means of irrigation, etc. – are currently the overriding objectives for improving the food situation and combating the poverty of the people. Furthermore, as by far the majority of the population is employed in the agricultural sector, and there are major path dependencies, pressing ahead with Virtual Water Trade at the expense of agriculture would not be socially tolerable.

Besides economic strength and social adaptive capacity, political factors play a part in determining the pros and cons of Virtual Water Trade. On the one hand, political will is needed if the credo of self-sufficiency is to be abandoned and dependence on the exporting country accepted. On the other hand, it must also be ensured, in keeping with good governance, that political decision-makers secure supplies of food to the rural population in particular.

The strategy of Virtual Water Trade can be used only partially to resolve conflicts between countries over water. A contribution can equally be made by any other strategy that helps to ease the resource situation. In other words, Virtual Water Trade is not specific in this respect.

Finally, ecological considerations should also play a part in the decision whether or not to promote the strategy. Virtual Water Trade does not automatically mean that the use of natural resources will be optimized. In the potential exporting countries in particular overuse of water and other resources, such as land, may occur (ecological rucksack).

Generally speaking, the greatest obstacle to strategic Virtual Water Trade is that trade in agricultural products depends on comparative cost advantages and so primarily on the factors of production, labour, land and capital. As in most developing countries appropriate prices and tariffs are not charged for water, its provision and purification or the necessary infrastructure, water is ruled out as a relevant cost factor. As a purely political concept (possibly entailing a decision against economic incentives), Virtual Water Trade is conceivable only in the event of absolute water scarcity. Otherwise, it will as a rule require far too much by way of subsidies and measures to cushion the negative consequences for it to be institutionalized. Water pricing is therefore the only way at global level.

Political decisions in favour of Virtual Water Trade, which seem far more practicable in this context, are, on the other hand, the regional and local solutions, as already explained.

10.3 Conclusions

The following conclusions can be drawn at this juncture:

— To conserve water resources, all existing, efficient approaches to the improved management of water resources should first be taken as a priority. This includes imposing restrictions on the growing of highly water-intensive crops in water-scarce countries. Integrated Water Resource Management (IWRM) is the decisive concept and must be applied here. Virtual Water Trade related to certain crops can then follow, but in no circumstances should they continue to be subsidized on political grounds. This is especially true of poor developing countries (LDCs) whose economies are based on agriculture.

— The situation is different for water-scarce countries with higher incomes (middle-income countries). Although here again IWRM must be used as the main concept for the sustainable use of water resources, there is also the option of complementing it with Virtual Water Trade, since appropriate foreign exchange can be generated to pay for food imports. Moreover, less negative socio-economic consequences are likely in these countries than in the poor developing countries.

— Virtual Water Trade within regions makes sense if they include water-scarce and water-rich countries where appropriate economic and social conditions prevail. This may be true of the SADC region, for example, if existing economic policy obstacles are removed and South-South trade is promoted accordingly.

— Virtual Water Trade within single countries is possibly the easiest to achieve and has the fewest negative implications. Both political and economic international dependencies are avoided in this way. Particularly important in this context are functioning transport and infrastructure, logistics and good governance. Internal Virtual Water Trade then has considerable potential, it even has ecological advantages, and it also contains within itself potential for the economic growth of the favoured agricultural regions. Virtual Water Trade – in the way it is suggested by Liu (2003) for China – seems to be very suitable and ecologically beneficial compared to other solutions of the water crises. However, the focus here would be to achieve the maximum sustainable exploitation of rain-fed agriculture in order to save blue water in other locations, which is better to be used for industrial purposes or for drinking water. Virtual Water Trade will tend to develop by itself when trade barriers are removed and appropriate water prices are set. Political shows of strength, which also pose serious governance risks, can thus be avoided. Here, too, some social cushioning will be inevitable.

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Appendix : Gross national savings and losses related to the international trade of agricultural products ($10^6 m^3/yr$) Period: 1997 - 2001

	Gross national saving (Gm^3/yr)			Gross national loss (Gm^3/yr)		
	Related to import of crop products	Related to import of livestock products	Total saving	Related to export of crop products	Related to export of livestock products	Total loss
Afghanistan	770	7	777	191	1	191
Albania	1393	284	1677	35	49	83
Algeria	42460	3453	45913	441	43	484
Angola	3034	556	3590	800	0	800
Argentina	2732	463	3195	45952	4172	50124
Armenia	539	141	680	24	3	27
Australia	5242	949	6190	38214	25217	63431
Austria	5548	1864	7412	1996	2852	4848
Azerbaijan	1242	140	1382	1037	96	1132
Bahrain	298	102	399	32	10	41
Bangladesh	4172	118	4290	771	652	1424
Barbados	169	119	288	107	8	115
Belarus	2452	245	2698	125	119	245
Belgium-Luxembourg	37633	5678	43311	14688	9825	24513
Belize	29	31	60	456	5	461
Benin	664	51	715	1937	8	1944
Bhutan	144	8	152	6	0	6
Bolivia	2073	424	2496	1858	394	2253
Botswana	1467	239	1706	8	154	162
Brazil	27006	2573	29580	53713	11901	65614
Bulgaria	1677	1185	2861	1778	423	2202
Burkina Faso	431	31	462	1544	10	1554
Burundi	102	3	105	329	0	330
Cambodia	812	39	851	25	24	49
Cameroon	1781	54	1835	8300	4	8304
Canada	17967	5105	23072	48321	17424	65745
Cape Verde	153	9	161	2	0	2
Central African Rep.	132	2	134	650	0	650
Chad	155	5	160	1960	6	1966
Chile	3144	806	3949	1122	265	1386
China	45863	33654	79517	17736	6024	23761
Colombia	8938	364	9302	10783	444	11227
Congo, DR	814	134	947	796	0	797
Costa Rica	2307	111	2419	2979	365	3344
Côte d'Ivoire	2622	175	2797	35029	13	35041
Croatia	1902	785	2687	464	308	772
Cuba	3784	392	4176	8628	15	8643
Cyprus	1637	114	1751	245	66	311
Czech Republic	4602	577	5178	2039	856	2895

	Gross national saving (Gm³/yr)			Gross national loss (Gm³/yr)		
	Related to import of crop products	Related to import of livestock products	Total saving	Related to export of crop products	Related to export of livestock products	Total loss
Denmark	7537	1436	8972	2696	9451	12147
Dominican Republic	0	0	0	3309	67	3376
Ecuador	3863	98	3961	7385	67	7451
Egypt	13175	2046	15220	1755	221	1976
El Salvador	2184	393	2577	2718	72	2790
Eritrea	1234	17	1251	14	18	31
Estonia	2929	279	3207	399	162	561
Ethiopia	803	4	807	2143	90	2233
Fiji Islands	0	0	0	564	9	574
Finland	3338	399	3737	1015	569	1584
France	39080	9022	48103	43410	13206	56616
Gabon	431	134	565	70	0	70
Gambia	942	47	989	142	1	142
Georgia	265	106	371	347	217	563
Germany	64876	14091	78967	27630	17429	45058
Ghana	2265	97	2361	19501	2	19502
Greece	5303	5952	11255	4634	330	4964
Guatemala	2322	509	2831	5684	166	5850
Guyana	154	42	196	1033	1	1034
Haiti	0	0	0	253	5	257
Honduras	1809	202	2011	3043	77	3120
Hungary	3397	3544	6941	3495	8586	12081
Iceland	210	2	213	9	62	71
India	22582	362	22944	32411	3406	35817
Indonesia	26425	1763	28188	24749	369	25118
Iran	40078	769	40846	3587	314	3901
Iraq	15011	961	15972	703	5	707
Israel	8176	2307	10482	575	139	714
Italy	49095	38068	87163	12920	14899	27819
Jamaica	1361	258	1619	489	11	501
Japan	78930	17036	95966	951	955	1905
Jordan	7666	710	8375	97	163	261
Kazakhstan	562	72	633	7363	648	8011
Kenya	3473	15	3488	4638	161	4799
Korea, DPR	2809	100	2909	31	19	50
Korea, Republic of	32321	6198	38519	997	3930	4927
Kuwait	1614	579	2193	30	23	53
Kyrgyzstan	0	0	0	296	128	423
Laos	176	11	187	246	22	268
Latvia	1042	243	1284	387	192	579
Lebanon	3569	1924	5492	212	75	287

	Gross national saving (Gm³/yr)			Gross national loss (Gm³/yr)		
	Related to import of crop products	Related to import of livestock products	Total saving	Related to export of crop products	Related to export of livestock products	Total loss
South Africa	10566	1147	11713	6326	1312	7638
Spain	38530	11453	49983	18252	8540	26791
Sri Lanka	1643	157	1800	2381	46	2427
Sudan	1085	26	1110	7251	273	7524
Suriname	38	7	45	178	1	179
Swaziland	0	0	0	0	0	0
Sweden	5289	1215	6504	2034	808	2842
Switzerland	5773	571	6344	1163	401	1564
Syria	15448	608	16056	4025	512	4537
Taiwan	13360	4000	17360	329	3559	3888
Tanzania	1695	17	1712	3173	52	3225
Thailand	13611	2022	15633	38307	2856	41163
Togo	570	13	583	1920	2	1922
Trinidad and Tobago	811	210	1021	350	15	365
Tunisia	6216	955	7171	11013	71	11084
Turkey	17078	1032	18110	11069	335	11404
Turkmenistan	221	98	318	1071	27	1098
Uganda	2569	5	2574	4432	77	4510
Ukraine	2247	407	2654	8154	2447	10602
United Arab Emirates	0	0	0	4603	475	5078
United Kingdom	36398	9017	45415	8773	3785	12559
Uruguay	675	161	836	2009	3348	5357
USA	50601	27488	78089	134611	35306	169917
Uzbekistan	1252	281	1533	6533	55	6588
Venezuela	15823	648	16472	1394	389	1783
Viet Nam	2516	379	2894	11124	165	11289
Yemen	8047	587	8634	243	37	280
Zambia	383	12	395	508	14	522
Zimbabwe	0	0	0	3032	319	3351
Others	16471	4685	21156	7227	9330	16557
Total	1285537	319723	1605260	978566	274551	1253117

Source: Chapagain, A. K. / A. Y. Heokstra / H. H. G. Savenije (2005): Saving Water through Global Trade. Research Report Series No. 17. UNESCO-IHE, Delft

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