TITLE (Work in progress. Do not cite)

Europe's unification, on a regional scale, and the world's globalisation on a larger scale have made people move together – economically, politically, environmentally, and socially. The topic of trading 'virtual water' in increasingly liberalised markets and the concept of the 'water footprints' of nations try to link water use and water consumption of people and to illustrate flows of 'virtual water' between countries, especially between "water-rich" and "water – poor" countries. In this context, the flow of virtual water out of the rather arid countries within the Mediterranean region to countries with large quantities of 'real' water resources could be considered a substantial problem and as such should be integrated into water management discourses.

Research on water management has been a priority in national and Euro-Mediterranean projects, especially in the INCO-Med programme. However, it has been observed that the products of these research programmes and projects can not be appropriately transformed into concrete implementation proposals and processes aiming for the improvement of the efficiency of water use and its management, due to non-functioning dialogue processes between the different protagonists, such as political bodies, administrative institutions, scientists, sociologists, lawyers, economists, end-users, citizens, etc. Within the 6th EU Framework Programme, the MELIA project (Mediterranean Dialogue on Integrated Water Management and Water Governance) aims to serve as a forum for such a dialogue process, and hence will be used in our study as an example in this regard.

We aim to introduce the topic of virtual water trade, based on results of an Austrian study on the virtual water content of products traded in Austria, into the above mentioned dialogue process of the Mediterranean region.

In this study carried out for the Agrarmarkt Austria Marketing GesmbH (AMA) the Sustainable Europe Research Institute (SERI) elaborated on the quantities of 'virtual water' used for the production of different agricultural commodities - produced in Mediterranean countries and in Austria - and imported and exported through the trade of these products. In the study the focus was put on the effects brought about by this 'water commerce', especially on the economy and the environment. Thereby, AMA's intention was to point out the impacts consumer behaviour in importing countries can have on the exporting ones.

As already mentioned above, the use and management of water is not limited to geographical or administrative borders. Therefore it is substantial to integrate not only stakeholders exporting virtual water, but also the importers, sometimes far away from the region affected by the actual water management problem.

In the context of the above mentioned dialogue process (MELIA) participants in the AMA project will be taking part in the envisioned international meetings. By means of that, stakeholders from different countries affected by the virtual water flow can coincide at the same time and the same location. Consequently, the collected data may lead to a better understanding of those processes and/or to further needed research activities.

MELIA is an ongoing project, thus we will, in the following, present mainly results of the AMA study and outline in the conclusion paragraph meaningful threads on how to integrate the outcomes into the non-Mediterranean countries' discourse on integrated water management.

1. Introduction

Freshwater is no longer taken for granted as plentiful and always available resource. More and more people, including countries in the EU, are experiencing droughts – as individuals in their day-to-day lives and as communities and nations. Today, many European countries are subject to waves of water deficit that affect their inhabitants and the ecosystems they depend on. Events in 2003 have further demonstrated how socio-economic factors, driving the

demand for water, have even made the wettest parts of Europe vulnerable to drought. In addition to drought impacts, overexploitation of water resources in some European countries and in the Mediterranean in general, especially for agriculture, increases the risk of water deficit.

The problem of water deficit resulting from resource overexploitation is further exacerbated by global warming which is likely to increase the variability of precipitation patterns, thereby changing the patterns of water availability on a quantitative, temporal and/or regional basis.

Therefore, the upper most level of water management is supposedly the global responsibility for shifts in the worldwide water distribution on a worldwide level.

Against this background the topic of virtual water trade has emerged as a strategic instrument in water policy and has become more and more important. The World Water Council dedicated a session of the 3rd World Water Forum to this issue and subsequently organised a broad e-conference already in 2003.

Virtual water trade as such is not a new concept, but with the increasing awareness of water scarcity it has gained more attention – as a possible optimisation instrument for the use of water as a scarce commodity in terms of sustainable and integrated water management.

The strength of the virtual water concept is that it embraces the whole water management in a country and allows for a deeper understanding of water use through e.g. consumer behaviour or broader optimisation of water allocation between different water users by incorporating access to external water resources through virtual water trade. The virtual water concepts thus can become, similar as the footprint concept of material flows, a practical policy tool.

2. Virtual water

1.1. The concept

By definition, virtual water is the volume of water required to produce a commodity or service (Chapagain and Hoekstra, 2004). Allan introduced this concept in the early 1990s (Allan, 1993, 1994) looking for an at least partial solution to problems of water scarcity in the Middle East. Following his idea a country could import virtual water through the import of food imports, in order to release the pressure on the scarcely available domestic water resources. Hence, the import of virtual water can be seen as additional water source for a country. At the same time, a country importing high amounts of virtual water from other parts of the world is in a certain kind of dependency relationship. The degree of dependency can be calculated by comparing the amounts of virtual water being imported and exported throughout a year.

Actually, the concept of virtual water enables to examine the actual water scarcity of a country from a new point of view. Chapagain and Hoekstra (2003a) and Haddadin (2003) calculated the imports of virtual water of Jordan, showing that water withdrawals from domestic water sources of 1 billion cubic metres a year are facing imports of virtual water of about 5 to 7 billion cubic metre. Following international theory, in an open economy a country with abundant water resources would trade water-intensive products exchanging them for products that need resources that are scarcely available. Vice versa, countries with scarce water resources would seek to import water-intensive products and export goods the production of which requires less amounts of water. Consequently, the pressure on the own water reserves would be relieved.

The import of virtual water from water-scarce countries, e.g. from the Mediterranean, has also been discussed under the term 'water rucksack'. In this context, the content of virtual water of a product is seen as a backpack filled with water – invisible for the consumer's eyes – coming along with the product as such (Giljum et al., yet unpublished). Thereby, the content of virtual water of a certain product can be calculated either for the producing country (with all its peculiarities in terms of production techniques, climate, etc.) or it can be determined how much water the production of the same product would have required if produced in the importing country itself.

On a cross-national level, the concept of virtual water – or water rucksacks – is gaining more and more importance, economically as well as politically. Due to the considerably increasing international trade of agricultural products higher and higher amounts of virtual water are being exchanged between different world regions. This development can have direct impacts on a country's or a region's environment as well as on the economy; especially if a country with limited water resources produces and exports high amounts of agricultural products, leading to an accentuation of its water scarcity situation. Hence, an excessive use of the own water resources is not only affecting the ecology but, consequently, also the economy. Therefore – closing the circle to the above mentioned arguments – it can be argued that for a wealthy country with scarce water reserves a specialisation on the export of goods of low water-intensity and a concurrent import of water-intensive agricultural products would be advisable.

1.2. Influencing factors

The virtual water content of a certain crop can vary significantly depending on the world region where it is grown. The main factors of influence are climatic circumstances and differing production and processing methods. Concerning the former, especially precipitation frequency and temperature, and connected with it humidity and the evapotranspiration of the crop play a main role. These conditions have to be seen as well from a seasonal point of view – as the consumption of water evidently increases when crops are grown in regions of high aridness (and low relative humidity) – while at the same time productivity is decreasing.
The latter factor of influence, differences in production and processing methods, are founded in the varying efficiencies in the use of water of different irrigation systems. While surface irrigation solely reaches efficiency values of around 30-50%, sprinkler irrigation can achieve 60-80% and drop-irrigation up to 80-95% (Supper, 2003).

Regarding the consumption side influencing the demand of virtual water, certainly the total consumption quantity of a country has to be taken into consideration, which in turn depends heavily on the GNP. Citizens of a wealthier country consume more and, consequently, use more water – a fact which is accentuated even more if this country additionally has a big population. Furthermore, the average diet of a country can affect the total water consumption considerably, as meet production is far more water-intensive than the production of vegetables.

1.3. Calculating the ‚virtual water content'

Following the calculation procedure elaborated by Chapagain und Hoekstra (2004) the virtual water content, *VWC*, of a plant, given in cubic metres per tonne [m³/t] or litre per kilogramme [l/kg] is calculated as follows:

$$VWC = \frac{CWR}{Yield}$$

CWR, the crop water requirement is the "total water needed for evapotranspiration, from planting to harvest for a given crop in a specific climate regime, when adequate soil water is maintained by rainfall and/or irrigation so that it does not limit plant growth and crop yield" (Allen *et al.*, 1998). In order to calculate the crop water demand, the plant's daily evapotranspiration [mm/day] is summed up over the whole growing period.
The *Yield* [t/ha or kg/ha] of a crop is the total production output set into relation with the total production area in hectares.

3. Case studies

In a study carried out for the Agrarmarkt Austria Marketing GesmbH (AMA) the Sustainable Europe Research Institute (SERI) elaborated on the quantities of 'virtual water' used for the production of different agricultural commodities - mainly produced in Mediterranean countries - and imported and exported through the trade of these products (Giljum et al., yet unpublished). In the study the focus was put on the effects brought about by this 'water commerce', especially on the economy and the environment. Thereby, AMA's intention was to point out the impacts consumer behaviour in importing countries can have on the exporting ones.

In the study, the virtual water content of different products produced in four different countries – South Africa, Spain, Israel, and Morocco – was calculated and compared with the water content of the same products produced in Austria. Additionally, the water content of the products was set in relation with the quantity of renewable water reserves in the respective countries. Here, we would like to highlight the results concerning the three Mediterranean countries – the EU-member Spain, Morocco, and Israel – and to provide the necessary systematic knowledge, in order to provide an scientific input for the water management discussion concentrated on in the context of the MELIA project.

As elaborated earlier, the virtual water content of a plant is determined mainly by two parameters – the crop water requirement, being subject to rates of evapotranspiration, and the yield of the crop. Hence, special attention is paid to these values.

Strawberries from Spain

Spain is the world's second largest producer of strawberries. In 2004 almost 335.000 tonnes were produced, which amounts for ~2% of the total fruit production in Spain. Around 70% of the strawberries were exported – mainly to Germany, France, and England (FAOSTAT, 2007).

In the year 2000, the share of agricultural area in Spain was around 37%, to which 68% of the total water withdrawal was dedicated mainly for irrigation purposes (FAOSTAT, 2007). The renewable water reserves came to ~7.500 litres per capita and day (Chapagain und Hoekstra, 2004).

Although evapotranspiration rates in Spain are considerably high (2.9 mm/d)– and, consequently, so are crop water requirements – supposedly due to production techniques, the yield of strawberries is very high (e.g. three times higher than in Austria), resulting in a noticeably low virtual water content. Nonetheless, by virtue of the low water reserves – especially in southern Spain where the main production fields lie – strawberry production in Spain has to be regarded as problematic.

Potatoes from Morocco

In 2004 Morocco produced ~1.5 million tonnes of potatoes, of which only 3% were exported. Potatoes are one of Morocco's main export product; exports go to France, Germany, Britain, and Spain (FAOSTAT, 2007).

In 2000, Morocco's withdrawal from the domestic renewable reserves amounted for 12.5 billions m³, the majority of which (87%) was used for irrigation (FAO, 2005). 22% per cent of the country area are under agricultural use of which 15% are irrigated (FAO, 2007). Regarding irrigation techniques, only 7% of the irrigated land receives drop-irrigation, while 10% are sprinkling and 83% surface irrigation (FAO, 2005). The renewable water reserves came to ~2.800 litres per capita and day (Chapagain und Hoekstra, 2004).

Evapotranspiration rates in Morocco are quite high (3.8 mm/d; compare Austria: 1.5 mm/d), and so is the crop water requirement of potatoes, while the yield is rather low. Consequently, the virtual water content is high (e.g. ~3:1 comparing with the VWC in Austria). Especially in view of the rather low renewable water reserves the potato production in Morocco has to be considered as environmentally critical.

Pepper from Israel

Almost 130.000 tonnes of pepper were produced in Israel in the year 2004, ~7% of the total vegetable production. More than 50% were exported – mainly to EU countries (FAOSTAT, 2007).

According to FAO statistics, in the year 2000 ~20% of the country area was under agricultural use. More or less 2 billion cubic metres of water were used in Israel, of which more than 60% were dedicated to irrigation purposes. Almost 50% of the total agricultural area was irrigated. As a consequence of drastically increasing water scarcity, the main irrigation type in Israel is drop-irrigation, which resulted in a reduction in water demand for irrigation purposes of up to 70%! In 2000, the renewable water reserves came to only 740 litres per capita and day (Chapagain und Hoekstra, 2004).

Similar to Spain, despite the fact evapotranspiration rates in Israel are very high the crop water requirement is relatively low and yields remarkably high, resulting in low virtual water content of Israeli pepper. Nevertheless, for the same reasons as in the case of Spain, the extremely low per capita water reserves (1:35 in comparison with Austria) seem to question the vegetable production in Israel.

General comments

The three Mediterranean countries observed in the AMA study can be seen as representative for a multitude of the countries in the area – in spite of low water reserves considerable amounts of products with high virtual water content are exported. And although in some cases the virtual water content of a crop may be relatively low, it is the dimension of the total production and consequently of the exports which causes an aggravation of the water scarcity. Additionally, in some cases the export of agricultural products amounts only for a small share in the total earnings of a country. Reducing the part of the production designated for the export would have only low impact on the local economy (Dietzenbacher und Velázquez, 2007). Certainly, there are also cultural arguments which have to be taken into consideration when discussing this issue.

4. The complexity of integrated water management

The concept of virtual water, specified through the elaborated case studies, shows that the realm of managing water resources at a national as well as at an international level is a quite complex one, taking place at various levels and including various different 'players', pointing out a new source of potential conflict.

On a national level, managing the existing water resources is not only an issue of adapting the existing demands to the present water reserves but also, and in combination with it, of providing for their just and equal distribution. The comparison of different countries' behaviours with regard to the trade of virtual water can be seen as innovative basis for a discussion in that sense. Still, it is one country's decision how to allocate the available resources and where to invest them.

But aquifers are not bound to national borders, nor do rivers stop at the crossing to the neighbouring country. Admitting and realizing this fact, the watershed-approach became the core of the EU water framework directive (EU Parliament, 2000), which 'encourages' the member states adjacent to one watershed to cooperate in the management of the same.

The international responsibility in terms of aggravating the water scarcity through importing water-intensive products might be given, but even if the consumers' behaviour and with it import strategies would be changed, and consequently the pressure on the water use in scarce countries would be eased, this would not per se cause an improvement in the dissemination of the additional water resources in the respective country.

Taken the issue of food security into account, each country is sovereign in the decision of how to realise its food security and its related water use and virtual water trade. This is necessary for the stability and future planning of a country. While water scarcity is a constraint to food production, the level of income primarily determines food security, especially in urbanised regions. The issue of food security is surely a politically sensitive one. Shopping for food in the world is at least a matter of risk analysis and costing.

Summarised, the multi-dimensionality of the water management issues makes them less tangible, as the involvement of various points of view of different stakeholders leads necessarily to strong conflicts of objectives. In the realm of Sustainable Development such rather undefined and complex situations are tried to be tackled by transdisciplinary dialogue processes.

5. Dialogue forum MELIA

The EU-research project MELIA (Mediterranean Dialogue on Integrated Water Management, *Coordinated Action* within the 6th Framework Programme) aims to support the transition to integrated water resources management by establishing a transdisciplinary dialogue platform for different protagonists, such as political bodies, administrative institutions, scientists, sociologists, lawyers, economists, end-users and citizens of all Mediterranean countries (see www.meliaproject.eu).
The Core Group partnership of MELIA has been structured in a way to include players with experience in the scientific, technical and socio-economic sectors, in past or on-going European, national or regional projects and networks, and committed to a dialog without prejudices; but also to incorporate other players, such as basin management organisations, water suppliers to cities, industrial groups, agriculture water users, and NGOs with contrasted experience in day to day management of water related issues.

6. Virtual water in the dialogue process

It seems to be evident to combine the two different approaches discussed above; on the one hand the complex topic of (virtual) water management, which we aim to introduce on the basis of the results of the comparative study to the MELIA project – the dialogue on integrated water management in the Mediterranean region – on the other hand.

Virtual water trade as a policy option requires thus a deeper understanding of its impacts not only related to international trade regimes but also on the local, social, environmental, economic and cultural situation.

The core of this innovative approach is the involvement of a, so far not considered, group of stakeholders – the group of non-Mediterranean consumers. These consume virtual water of Mediterranean sources through imported products and goods. In other words, external players are affecting directly as well as indirectly the demand on water in the region, which may increase local water scarcity problems. Hence, the MELIA project will serve as a platform where internal and external stakeholders with obviously different background and interests come together. Intrinsic conflicts of objectives can thus be experienced, and problems of water scarcity in the context of virtual trade be communicated to the co-responsibles. In the final paper we will present at the conference a review of the issues being in the discourse of virtual water trade.

By that means the group of consumers outside of the Mediterranean area might become aware of a, so far not perceived, aspect of their behaviour, and realise the responsibility/effect they have on basic living conditions outside of their social world.
We aim to address specifically issues of food security and consumer diet.
We expect first steps of integration of knowledge and experiences of both stakeholder groups – internal as well as external. Outcomes of the dialogue processes will be documented and presented at the MELIA website and may serve as a valuable source of information. These information will then be integrated within the Austrian study. The subsequent analysis of further needed research activities will be published.

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