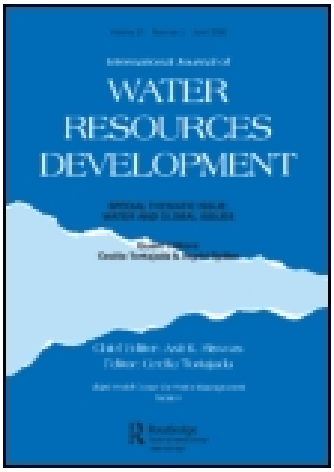

International Journal of Water Resources Development
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/cijw20

Virtual Water and Water Footprints: Policy Relevant or Simply Descriptive?

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Published online: 24 Nov 2010.

To cite this article: Dennis Wichelns (2010) Virtual Water and Water Footprints: Policy Relevant or Simply Descriptive?, International Journal of Water Resources Development, 26:4, 689-695, DOI: 10.1080/07900627.2010.519533

To link to this article: http://dx.doi.org/10.1080/07900627.2010.519533

Water Resources Development,
Vol. 26, No. 4, 689–695, December 2010

REVIEW ESSAY

Virtual Water and Water Footprints: Policy Relevant or Simply Descriptive?

Water Footprint and Virtual Water Trade in Spain: Policy Implications
Natural Resource Management and Policy (Series)
Alberto Garrido, M. Ramón Llamas, Consuelo Varela-Ortega, Paula Novo, Roberto Rodríguez-Casado and Maite M. Aldaya
New York, NY, Springer and Fundación Marcelino Botín, 2010

It is challenging to keep pace with the many scholarly papers and articles in the popular press that are published each year on the topics of virtual water and water footprints. Many authors have taken up the task of estimating the 'flows of virtual water' between countries and describing the internal and external water footprints of countries, regions, and provinces. Some of the authors describe the blue and green components of their virtual water estimates, and they suggest that 'trading' green water for blue water will enhance aggregate water productivity. The message and recommendations implicit in many of the virtual water articles is that arid countries should import water-intensive crops and livestock products from humid countries, while using their own water supplies for higher valued activities.

To many observers the depictions of virtual water trading between countries are attractive and the recommendations arising from virtual water analyses compelling. At first glance, it seems sensible to consider the water 'embedded' in crop and livestock products when examining international trade, particularly trade involving arid and humid countries. Surely arid countries will gain value by importing water-intensive crops, rather than producing them with their limited water resources. It is easy to agree with such an intuitively appealing statement.

Water footprint analysis is equally compelling from a casual perspective. Surely it must be sensible to reduce the amount of water used to produce goods and services. Hence, what could be wrong with promoting smaller water footprints? If our goals are to optimize water use within countries and to achieve the greatest benefits from global water resources, why should we not consider water footprints and virtual water trade?

Although seemingly attractive and compelling to many observers, most of the analyses of virtual water and water footprints fall short of advancing our understanding of important water resource issues and contributing to policy analysis in meaningful ways. The fundamental problem is the absence of a legitimate conceptual framework in support of virtual water analysis. There is no underlying theory suggesting that arid regions should always import water-intensive products from humid regions or that the net gains from such

0790-0627 Print/1360-0648 Online/10/040689-7 © 2010 Dennis Wichelns
DOI: 10.1080/07900627.2010.519533

transactions will be positive. The calculations and discussion that characterize much of the virtual water and water footprint literature appeal to many readers, but the articles and reports do not contain sufficient information to determine optimal policy decisions.

It is tempting to consider that virtual water is analogous to the economic concept of comparative advantage, which is an important tenet of economic theory. However, virtual water analyses resemble more closely applications of absolute advantage, in which one compares only resource endowments and production capabilities. Opportunity costs are not considered. Hence, neither absolute advantage nor virtual water is a sufficient perspective for determining optimal production and trading strategies. Public officials who make policy decisions based only on recommendations that arise from studies of the virtual water contents of crop and livestock products will not be considering the full range of pertinent information.

The authors of *Water Footprint and Virtual Water Trade in Spain: Policy Implications* might or might not be aware of this fundamental limitation of the analysis of virtual water and water footprints. The book's title suggests they will contribute to policy discussions regarding water resource issues in Spain. The authors suggest in their Introduction that better knowledge of virtual water and water footprints can be useful in achieving a more efficient allocation of water resources, particularly in arid and semiarid countries. They propose (p. 3) that a significant innovation of their work is the analysis of economic and ecological factors that will enable policy-makers to balance the trade-off between water for nature and water for rural livelihoods. Their analysis of water footprints will 'provide new data and perspectives for a more optimistic outlook' regarding potential water scarcity crises, and 'this new knowledge is changing traditional water and food security concepts that most policy makers have held until now.'

The book's title and several introductory statements seem overly ambitious, given the inherent limitations of the virtual water and water footprint perspectives. The authors recognize the lack of economic analysis in much of the existing literature regarding virtual water and water footprints. They endeavour to enhance their own analysis by considering water productivity, water scarcity and opportunity costs. They consider also the blue and green components of virtual water and water footprints in an effort to describe how these measures vary during droughts, water shortages, and periods of notable rainfall. Pertinent questions for readers should include whether or not the authors succeed in enhancing the legitimacy of virtual water and water footprint analyses, and if they truly contribute to the understanding of optimal resource strategies and the discussion of policy alternatives. A few additional questions also seem pertinent.

Can Economic Analysis Enhance the Virtual Water Perspective?

The authors endeavour to enhance previous estimates of virtual water and water footprints by adding an economic dimension to their analysis. To this end, they introduce a measure of 'water-apparent productivity', which is calculated by dividing market price by the volume of water required to produce a given crop. The resulting measure, expressed as €/m^3, is the inverse of the authors' measure of virtual water content, when expressed as m^3/€. The authors use their measure of water-apparent productivity when examining the spatial and time dimensions of water footprints pertaining to Spanish crop production. They suggest (p. 48) that their economic analysis of water footprints is one of the book's main contributions to existing literature.

The authors present their estimates of water-apparent productivity in Spanish agriculture, along with estimates of total water use, by crop, in figure 5.7 (p. 50). Cereals account for the largest amount of water use, while water-apparent productivity is highest for vegetables and grapes. These results are not surprising, as cereals are produced on 40% of the cropland in Spain, while vegetables and grapes are produced on much smaller areas. The measure of water-apparent productivity is essentially the average value product of water in crop production. It should be expected that the average and marginal value products of water will be higher for vegetables and grapes than for cereals and pulses.

There are many reasons why farmers choose to produce one crop or another, including production technology, input and output prices, resource endowments, human capital, and market access. The information presented in figure 5.7, which focuses only on water, does not address any of these important issues. In addition, the information does not address the opportunity costs or shadow values of water use in Spanish agriculture or any other sector. Hence, it is not clear why the authors propose 'to stop servicing the least productive crops and to transfer the resources to environmental uses or to other more productive water uses such as urban water supply or industry' (p. 49). Such a statement, based on very limited analysis, is typical of the many normative statements that appear in the virtual water literature. The authors' recommendation is not truly supported by analysis presented in the book, which does not consider appropriately the opportunity costs of water use in any sector.

The authors do not make similar recommendations regarding water use in livestock production, industries or urban areas. Their discussion of the economic aspects of water footprints in those sectors is somewhat terse. They have a bit more to say on the economics of water footprints in the Guadiana Basin, yet here again they suggest that water should not be used to produce low-value crops. They propose this policy direction without sufficient consideration of opportunity costs or the many agronomic, technical, and economic variables that influence production decisions and social values. There is no evident scientific or economic basis for their suggestion that 'the policy in the immediate future has to be more cash per drop' (p. 76).

Virtual Water Trade: Is It or Isn't It?

Chapter 6 summarizes the authors' estimates of water embedded in the crop and livestock products that comprise Spain's imports and exports. In this chapter—and throughout—the authors always place the words *trade, imports, exports*, and *flows* in quotation marks when accompanied by the phrase *virtual water*. This practice might lead one to consider that the authors are not fully comfortable with the notions of virtual water flows, trade, imports and exports. One might reasonably wonder if they realize such notions are questionable constructs that, while gaining the attention of many casual observers, lack the conceptual or empirical basis needed to guide policy decisions. The authors acknowledge correctly that countries engage in the trade of goods and services for many reasons that lie outside the scope of virtual water analysis, yet much of their discussion is notably water centric. Placing key terms in quotes might deflect some potential criticism of the suggestion that trade revolves around water, but it cannot improve the appropriateness or enhance the usefulness of the virtual water and water footprint perspectives.

When discussing the economic valuation of Spain's virtual water imports, the authors distinguish between the green and blue components of water resources used to produce

imported crops. The purpose and meaning of this distinction is not completely clear. Why should it matter to Spain if the crops it imports are produced largely with green or blue water? Should not the French, rather than the Spanish, be concerned about the use of French blue water in the crops exported to Spain? If the residents of Spain or other countries wish to express their concern for regional or global water-use efficiency, they should consider the opportunity costs and other implications of water use in each setting, rather than focusing only on crop water requirements.

The discussion of land and water productivities in the first half of Chapter 7 is interesting, but some readers might wonder why we need the terminology and constructs of land and water 'apparent productivities' to analyse crop yields, water use and agricultural productivity. We already have useful terms and concepts in agronomy, water science and economics for such purposes. One might note also that while the authors use constant 2000 prices when calculating production values per hectare, that approach is not sufficient to remove price effects from the resulting information. In particular, the changing prices of inputs and outputs will influence farm-level decisions regarding cropping patterns and input use. Hence, an input might appear to be more productive in one year than another, largely because farmers applied additional units of a complementary input. For example, farmers might apply more fertilizer when the price of maize increases, thus enhancing the incremental productivity of water and other inputs. This is yet another reason why focusing intently on water productivity, while not considering output prices and the impacts of other essential inputs, is potentially problematic.

The value added by the regression analysis presented in the second half of Chapter 7 is not completely clear. Some of the data series have been constructed by the authors using their assessments of water-scarcity values and water-quality indicators. As such, the data do not reflect repeated observations of independent variables pertaining to a set of fixed regressors. Of equal concern are interpretations involving virtual water exports, as if such a construct is appropriate. In sum, the econometric analysis might be of interest to some readers, but it does not add credibility or pertinence to the analysis of virtual water and water footprints or the description of water resources in blue and green categories.

In the last section of Chapter 7, the authors consider Spain's virtual water imports and exports in the context of economic growth. They conclude that 'Spanish economic growth is decoupled from all the primary water variables (water footprint and water use)' (p. 121). Such an observation is not surprising given that water is just one input in the production of a wide range of goods and services. Yet the authors strive to insert consideration of virtual water imports and exports by noting the rate of growth in virtual water imports, suggesting that 'Spain is also supplying water to the rest of the world in the form of virtual water exports' (p. 122). The pertinence of such a statement is unclear. Spain provides goods and services in response to international demands. Water and many other inputs are involved in producing those goods and services. The discussion (pp. 122, 123) of 'water exchange terms' calculated by comparing virtual water imports and exports also is of questionable value.

New Insights or Strained Efforts to Impose Alternative Terminology?

In the first portion of Chapter 8, the authors note several major conclusions of their work, with implications for policy-relevant issues:

- Spain's water sector is mature, as there is little correlation between economic output and annual water availability.
- Yet most of Spain's water resources are still used in agriculture.
- The gap between crop water productivities in mainland and Mediterranean regions is narrowing.
- Green and blue water are valuable across basins, years and crops.

The first three of these conclusions likely could be obtained without invoking the notions of virtual water and water footprints. The authors compare their estimates of national water footprints and virtual water imports and exports with annual gross domestic product in table 7.9 (p. 121). One could likely conduct a similar analysis using published reports of water diversions and agricultural production. The second conclusion likely could be obtained using similar information. The gap between crop water productivities in two regions can be examined and described using existing analytical methods and terminology. There is no need to speak of virtual water or water footprints, or green water and blue water, when examining differentials in agricultural productivity.

The fourth conclusion is consistent with the authors' estimates of the economic value of blue water resources in Spain. It also reflects the generally positive incremental value of water in a country where many farmers rely on irrigation to produce cereals, legumes, and increasing amounts of higher-valued fruits and vegetables.

Several statements in later sections of Chapter 8 reveal a strained effort to attribute the well-known gains of engaging in international trade to the notion of trading virtual water between countries. For example, the authors state that 'at the global level, virtual water trade facilitates specialization and competitiveness, by adding more valuable products to both domestic and international markets than would otherwise be the case' (p. 132). Replacing 'virtual water trade' with 'international trade in goods and services' would produce a more accurate and meaningful statement.

The authors suggest (p. 129) that international trade in virtual water has the potential to improve water allocation and water-use efficiency. They then state that 'Spain has in fact "saved" billions of cubic meters by opening its farming industry to world market competitiveness and has been able to offer foreign consumers competitively priced products' (p. 135). While the intent of these statements is not completely clear, one might argue that water allocation and efficiency are determined largely by local and national policies. International trade enables residents in both importing and exporting countries to expand consumption opportunities. In open-market economies, consumers and producers respond to international prices in selecting strategies that maximize net benefits. Water and other natural resources will be exploited or used inefficiently if local or national policies regarding those resources are incorrect or inadequate. Local and national governments are responsible for implementing appropriate policies. International trade should not be held responsible for—or relied upon to solve—water-management problems due to inappropriate local and national policies.

Speaking somewhat empirically, the authors consider that 'commodities trade can move billions of cubic meters at a relatively low cost, compared to the equivalent physical transfer of the same amount of water, simply by following the signals provided by commodity markets' (p. 131). This statement is problematic on two levels. First, it is not helpful to consider that importers and exporters trade in the water used to produce crops. They trade in commodities. Second, the prospect of transferring large volumes

of agricultural water supplies between countries is not likely. Hence, the suggestion to compare the cost of trading water or trading commodities is not particularly helpful.

The authors suggest that 'one of the clear normative conclusions from our work is that options to save water and to increase water efficiency should be given priority over additional water supply measures' (p. 134). Such a perspective might seem new to some readers, but many analysts have reached this conclusion already, without the consideration of virtual water and water footprints. Many water-management agencies have acknowledged long ago the importance of focusing on water-demand management rather than on supply augmentation.

Summing Up

The interesting and useful information in this book lies outside the scope of its title and purpose. In particular, the authors' discussion of agriculture and water resources is Spain is timely and appropriate, as is their analysis of water productivities in mainland and Mediterranean regions. The authors also present an interesting analysis of changes in land use and crop yields over time in the context of agricultural policy reform. They also describe interesting links involving water resources and agricultural production in Spanish provinces. All of that analysis can be conducted successfully without consideration of virtual water and water footprints. Those notions and the authors' discussion will appeal to some readers, but the analysis and recommendations involving virtual water and water footprints are not necessary and they do not advance understanding of important water issues.

Some readers likely will suggest that the analysis and conclusions add credibility and stature to the application of virtual water and water footprints to water policy questions. Such a perspective would be misplaced. The notions of virtual water and water footprints can be helpful in gaining the attention of community residents and public officials regarding water resource issues, but lacking a legitimate conceptual framework, they cannot be used alone to determine optimal policy decisions.

Scholars and practitioners interested in virtual water and water footprints should read the book carefully and consider for themselves the issues raised in this review. Readers might ask themselves the following six sets of questions as they read and consider the authors' analysis and discussion:

(1) Is there truly such a thing as virtual water trade, i.e. do countries truly trade water or do they trade goods and services?
(2) If the answer to the first question is 'goods and services', what information or insight is gained by attempting to describe international trade in terms of virtual water?
(3) Why should water be singled out in such analysis? Should we not be concerned also with other valuable inputs, such as labour, energy, seeds, nutrients and land? If water is special in some ways, should we not consider its opportunity cost, the use of complementary inputs and other implications of water use in each setting?
(4) Do we truly enhance understanding of water resource issues by using terms such as *green* and *blue water* in place of technically appropriate terms such as *soil moisture*, *surface water* and *groundwater*?

(5) Does it really matter to an importing country if the agricultural products it imports are produced primarily with soil moisture, rather than deep groundwater or water delivered in a surface canal? If the residents of an importing country wish to express a preference regarding production conditions or input use in an exporting country, should they not consider the opportunity costs and other implications of water use in each setting?
(6) Should we view virtual water and water footprints as policy-relevant analytical constructs or simply descriptive notions of water use that lack the conceptual foundation required to determine optimal policy decisions?

Thoughtful answers to these questions will enhance one's understanding of the potential usefulness and limitations of analyses involving virtual water and water footprints.

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