



Short Note

Linking the water-energy-food nexus and sustainable development indicators for the Mediterranean region



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ABSTRACT

Water use and agricultural practices in the Mediterranean area are unsustainable. The situation is worsened by the increased frequency of droughts and floods, as well as desertification and soil depletion, associated with climate change. The aim of Partnership for Research and Innovation in the Mediterranean Area (PRIMA) is to foster an integrated programme of sustainable food production and water provision in the framework of the water-energy-food nexus. A monitoring tool developed under PRIMA is based on the Sustainable Development Goals, two of which are specifically dedicated to food security (SDG 2) and sustainable management of water (SDG 6).

The 12 indicators that have been chosen to be monitored in the Mediterranean area are: Multidimensional Poverty Index (MPI); population overweight (%); land use (%); GHG emissions (total and AFOLU)(tCO_{2e}); cereal yield (kg/ha); agriculture value added (US\$/worker); fertilizer consumption (kg/ha_{arable land}); crop water productivity (kg/m³); annual freshwater withdrawal for agriculture (%); population served using with safely managed water service (rural, %); population served using with safely managed sanitation (rural, %); amount of agricultural residues used for energy purposes (t). Datasets for these indicators are collected by international bodies such as the World Bank, WHO, FAO and UNFCCC; recent series are available for almost all Mediterranean countries and are constantly updated. The aim of the proposed monitoring tool is to keep track of the impact generated in by PRIMA research and innovation projects Mediterranean countries.

1. Introduction

Food production and water provision are two urgent socio-economic and environmental issues in the Mediterranean region. Because these two aspects are closely linked, they need to be tackled by an integrated approach known as *Water-Energy-Food (WEF) Nexus* (e.g. Bazilian et al., 2011; Rasul, 2014; Riccardini and De Rosa, 2016;

Ringler et al., 2013). The recent global food crises of 2008 (Headey and Fan, 2010) and 2011¹ (Hochmana et al., 2014) drew attention to the crucial role of food security in the Mediterranean area, especially considering the consequences for socio-political equilibrium in certain countries of the Middle East and North Africa (MENA) (Ferragina, 2015). By 2050, the food imbalance in this region, which depends more on cereal imports than any other region in the world, is forecast to

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¹ “After reviewing the evidence, the study suggests the 2007/2008 food crisis was primarily driven by a combination of rising oil prices, a greater demand for biofuels and trade shocks in the food market. Rising oil prices led to increased costs of cereal production, as agriculture is generally an energy intensive enterprise. At the same time, there was increasing demand for cereal foods from wealthy oil-exporting countries. More importantly, higher energy prices increased the demand for biofuels, which became more competitively priced when compared with oil. In particular, this drove up the demand for biofuels derived from maize in the United States” (European Commission, 2011). “A sharp escalation in the price of basic foods is of special concern to the world’s poor. All poor people spend large portions of their household budgets on food, and most impoverished people depend on food production for their livelihoods but have very limited capacity to adjust quickly to sharp changes in relative prices. Consequently, surging food prices have caused panic and protest in developing countries and have presented the policymaking community with a challenge at least as severe as the 1972–74 global food crisis.” (Headey and Fan, 2010). See also: Hochmana et al. (2014), Pages 106–114.

reach nearly 60%, making MENA extremely vulnerable in terms of food security (IPEMED, 2010). The sustainable management of water resources is closely related to food security, since 70% of total global freshwater withdrawals are driven by agriculture (FAO, 2014). Energy plays a key role in producing and distributing food, as well as in extracting, treating and supplying water (FAO, 2014).

Problem solving in the frame of the WEF Nexus is expected to become more challenging due to the impacts of climate change and other factors, such as population growth, urbanization and change of diet. Water resources are expected to decrease further, while municipal and agricultural water demand is increasing in the region, also driven by population growth on the southern shore. On the basis of climate projections to 2050 elaborated by the Intergovernmental Panel on Climate Change (IPCC, 2013), the Euro-Mediterranean Center on Climate Change (CMCC) confirms that an average temperature increase of 2 °C would generate a 6–12 cm rise in Mediterranean sea level, a 5–10% fall in precipitation and more frequent extreme climatic events (Ferragina, 2015). According to this scenario, the agricultural production of countries on the southern and eastern shores will decrease by 50% by the end of the century (Porter et al., 2014). Hence, adaptation of Mediterranean society to climate change requires a new cross-sectoral approach to the management of energy and water resources aimed at “doing more and better with less”. Such management solutions should be inspired by a philosophy of mutual benefit for each sector and should prevent adoption of policies that might privilege one sector to the detriment of another. PRIMA² was recently launched with the specific aim of fostering an integrated programme on sustainable food systems and water resources for the development of inclusive, sustainable and healthy Mediterranean societies.

Recent adoption of the Sustainable Development Goals (SDGs) by all UN member states, promoted by the United Nations Sustainable Development Solution Network (UN-SDSN, 2015), offers an appropriate framework to track impacts of WEF-related measures in the Mediterranean region. Indeed, among the 17 SDGs, three specific goals are dedicated to nexus problems. These are: 1) *food security* (SDG 2 – End hunger, achieve food security and improved nutrition and promote sustainable agriculture); 2) *sustainable management of water* (SDG 6 – Ensure availability and sustainable management of water and sanitation for all); 3) *affordable and clean energy* (SDG 7 – Ensure access to affordable, reliable, sustainable and modern energy for all). Many other aspects related to food production systems, water resources and clean energy also cut across different goals (*cross-cutting issues*). This means that improving efficiency and sustainability in the WEF Nexus can have a positive domino effect, promoting progress in other goals.

The aim of this study is to introduce a monitoring tool based on selected indicators shaped on the SDG framework. The purpose of the tool is to obtain information on the effects of PRIMA research and innovation, addressing WEF interdependency in the Mediterranean region, although the E (Energy) component of WEF is clearly underestimated because the primary objective of PRIMA is more “water and food” oriented.

The Inter-Agency and Expert Group (IAEG) of the United Nations has suggested around 230 indicators for monitoring progress towards the 17 SDGs (UN, 2016) and an approach that relies on the relationship between indicators and targets, which are sublevels of the SDGs. However, targets can be misleading because they tend to be reductionist and at odds with the complexity of interactions across goals. The monitoring tool proposed in this paper pays more attention to goals than to targets. This will help overcome what Costanza et al. (2014) defined a missing element of the SDG definition process, namely the “articulation and measurement of the overarching goal or ‘ultimate end’ of the SDGs and how the list of sub-goals and targets contribute to achieving that larger goal”.

Section 2 of this paper explains the criteria used to identify the indicators to be monitored. Each indicator is then described in detail and the geographical area is outlined. Section 3 is dedicated to a description of the monitoring tool. The baseline is presented and the results shown graphically. Insights into the monitoring process at local scale are also given. The last section of the paper provides some recommendations on how the monitoring tool can be used to help the decision-making on WEF Nexus-related issues in the Mediterranean region.

2. Selection of sustainable development indicators

To implement this systems approach for the Mediterranean region, we developed a monitoring tool based on a set of indicators satisfying the following criteria:

- *Cover most SDGs*: the indicators should be able to monitor the progress of Mediterranean decision-making bodies in achieving as many goals as possible, in addition to SDGs concerned with *food security, water provision and access to energy* (i.e. cross-cutting issues).
- *Consider biophysical limits*: it is fundamental to have indicators that give information about the biophysical limits of the system, both from the resource consumption and environmental loading viewpoints.
- *Consider the nexus*: water, energy and food have a strong relationship with each other and play a crucial role in the achievement of SDGs; the use of indicators that can highlight the linkages among all three is needed.
- *Consider both national and sectoral systems*: some indicators have to monitor national systems (e.g. poverty, health, land use, GHG emissions), while others shall monitor sectoral systems (e.g. agriculture, water services).
- *Be limited in number*: the indicators should be limited in number in order to be an effective tool that can easily support the monitoring process of evaluated systems.
- *Data availability should be guaranteed* frequently enough to be meaningful in the desired time horizon.

To this end we have shortlisted a set of indicators (see Table 1) among those provided by UN-SDSN (2015), rather than using the indicators released by UN-IAEG (2016). We believe that, in this way, the monitoring tool is more consistent with the needed systems approach, avoiding the reductionism of a target based approach. Moreover, the indicators we selected have the capacity of describing not only the specific goals the PRIMA programme refers to (namely #2 and #6), but also the influence on the remainder of the goals (see Table 2).

Among the selected indicators providing a picture of the Mediterranean region, four of them deliver information at local scale with a spatial resolution of 5 km × 5 km. The relevance of such indicators is related to the above criterion on the biophysical limits of the evaluated system by providing a frame for spatially explicit assessments.

2.1. Indicator description

For each indicator a brief description is given in the following, to explain their meaning, the reason for their selection and the source of data upon which they are based.

2.1.1. Multidimensional Poverty Index (MPI)

This is an international poverty indicator developed by the Oxford Poverty and Human Development Initiative (OPHI) of the United Nations Development Program. The index reflects the multiple deprivations that a poor person faces with respect to education, health and living standards. According to Alkire and Foster (2011), the MPI is an index of acute multidimensional poverty. It assesses the nature and

² <http://prima-med.org>.

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