Towards Sustainable Water Use: Experiences from the Projects AFRHINET and Baltic Flows

Walter Leal Filho, Josep de la Trincheria and Johanna Vogt

Abstract This paper presents an analysis of the subject sustainable water use and discusses its many ramifications. It also introduces two projects being undertaken at the Hamburg University of Applied Sciences, which aim to put the principles of sustainable water management into practice.

Keywords Sustainability · Water use · Baltic · Africa · Rainwater · Management

1 Introduction: Sustainable Water Use

Water is one of the essential resources for a human being. Availability of water resources has great impacts on the environmental, political and economic situations as well. According to WHO and UNICEF, it has been estimated that more than 2 billion people are affected by water shortages worldwide (WHO/UNICEF 2000 in United Nations 2003). In addition, approximately 780 million people around the globe do not have an access to clean water. This is a result of wasteful water usage that is caused amongst other reasons by improper economic incentives, underinvestment, poor management systems, obsolete equipment and failure to apply existing technologies (Pacific Institute 2014).

According to UN projections, by the year 2025, water abstraction in developed countries will increase by 18 % (United Nations 2003), whereas by 2050, at least one in four people will live in a country affected by chronic or recurring shortages of freshwater (Gardner-Outlaw and Engelman 1997 in United Nations 2003). These facts show the current and potential future risks associated with the problem of the scarcity of water resources.

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In 1998, the issue of sustainable water use and management, as well as required measures, was addressed by the Commission on Sustainable Development (United Nations 1998). Experts define the sustainable use of water resources as the avoidance of any kind of welfare losses in the use of water resources (Bithas 2008). Sustainable water management focuses on water quality and quantity and requires society to conserve and use it more efficiently (EEA 2012b).

Until today, Europe has mostly been insulated from economic, social and environmental impacts of water shortages (EEA 2009) due to its abundance of water resources. In comparison with the global average, only around 13 % of all renewable and accessible freshwater from natural water bodies, including surface waters (rivers and lakes) and groundwater (EEA 2012b) is withdrawn to meet water demand. An average European directly uses approximately 130 L of water per day (EEA 2014c). Groundwater satisfies about 55 % of public water demand (EEA 2009 in EEA 2012b).

Despite the projections that the amount of water abstraction globally will increase, according to the EEA, in Europe, this amount is expected to decrease by about 11 % between 2000 and 2030 with pronounced decreases in western Europe. The future water demand of the "domestic sector", which includes households and small businesses, remains highly uncertain and will depend on a wide range of factors, such as income, size of households, age distribution of population and technology (EEA 2007).

In addition to households, the other main users of water are agriculture, industry and the energy sector (EEA 2014b). Discounting the disparity between regions, Europe as a whole uses around 30 % of abstracted water in agriculture, 30 % in energy production for cooling purposes, 25 % for public water supply and 15 % is used by industry (EEA 2012b).

However, prolonged periods of low rainfall or drought caused by global climate change and overabstraction due to increasing demand have significantly influenced the balance between water demand and availability, which have reached the critical level in many areas of Europe (EEA 2009). For example, one of the drivers of increasing agricultural water use across Europe over the last two decades is the Common Agricultural Policy (CAP). In some cases, the policy provides subsidies to produce water-intensive crops (EEA 2009).

The European Union requires all countries to promote sustainable water use based on long-term projection of available water resources and to ensure a balance between abstraction and recharge of groundwater (EEA 2013). These requirements are expressed in EU water legislation and policies.

The Water Framework Directive and the Sixth Environment Action Programme define the boundaries and set goals for sustainable water use and oblige the Member States to achieve "good status for surface and groundwater" of water bodies by 2015. The main goal is to prevent environmental degradation and restore or maintain sustainability via management of the combined impacts of water use and pollution pressures (Werner and Collins 2012). It covers all water categories, such as rivers, lakes, groundwater, coastal and transitional waters (EEA 2014e).

In addition, recent reforms of the CAP reduce the link between subsidies and production from agriculture and intensively promote the adoption of agri-environmental schemes, with measures related to a more sustainable use of the water resource by agriculture in future (EEA 2009).

The European Community has also signed the Watercourses and International Lakes Convention that establishes main principles and rules to develop and promote coordinated measures of sustainable use of water and related resources of trans-boundary rivers and international lakes (EEA 2013).

One of the water indicators used by UNEP, OECD and EUROSTAT (EEA 2013) that describes water status and trends and gives a general oversight of water issues in Europe is the Water Exploitation Index (WEI) (McGlade 2008). WEI is the total freshwater abstraction (i.e. water removed from any freshwater source, either permanently or temporarily, including mine water, drainage water and abstractions from precipitation) divided by the long-term average available water expressed as a percentage (Eurostat 2014). A value above 20 % indicates a stress on freshwater ecosystems from overabstraction (EEA 2012b). A value that exceeds 40 % indicates a severe scarcity (Eurostat 2014).

An example of this is in Poland between the years 2002 and 2011. In this case, the value of WEI ranged between 18 and 19.4 %, with 18.9 % in 2011. There are no available WEI values in Estonia, whereas in Germany, the only available WEI value is 18.9 % from the year 2004. Amongst the Baltic countries, Latvia and Sweden have the lowest WEI values that equal to 0.6–1.4 and 1.4 %, respectively (Eurostat 2014).

2 Some Projects Working on Sustainable Water Use

This section describes two large projects on sustainable water use being undertaken at the Hamburg University of Applied Sciences, as examples of what can be achieved.

2.1 Project 1—Baltic Flows Project—Monitoring and Management of Flowing Rain Water in Baltic Sea Catchment Areas

The Baltic Flows project is a scheme funded by the European Union Seventh Framework Programme. It concerns rainwater monitoring and management in Baltic Sea catchment areas. Rainwater, when available in large amounts, can form streams and rivers. In urban environments, heavy rain can also amount to storm water and floods. Over the years, much of this rainwater ends up in the sea. In northern Europe, the Baltic Sea conceals a history of water quality from streams, rivers and urban run-off in catchment areas. Encircled by a mix of Nordic, Central and Eastern European countries, the Baltic Sea is at the mercy of a range of national pollution and water treatment policies.

Several initiatives and projects have studied the state of the Baltic Sea and aim at improving water quality via various preservation measures. These include the Baltic Sea Action Plan by the Helsinki Commission, Finland, and the European Union's Baltic Sea Region Interreg programme.

The idea behind Baltic Flows project is that rainwater should be monitored and managed before it reaches the sea. Pollution should be detected as early as possible, preferably in high water than downstream regions. To achieve this, we should embrace three strengthening phenomena in modern society:

- increased miniaturisation of technology;
- increased citizen participation, social media; and
- understanding of urban planning.

Miniaturisation is enabling new small-size, low-cost technology. This will gradually shift the balance from individual, high-cost devices towards low-cost, small-size devices that can be installed in the masses. In future, miniature low-cost water measurement technology capable of wirelessly relaying real-time data will enable water monitoring networks of unforeseen coverage and timeliness. In addition, devices could harvest required energy from flowing water, thus eliminating the need for a power infrastructure.

In the Baltic Flows project, a total of 45 organisations will combine forces to reach a new level of world-class know-how in rainwater monitoring and management. The project consortium, comprising 14 organisations from five European regions—Estonia, Finland, Germany, Latvia and Sweden, in addition to two partner organisations collaborating via indirect representation, will form the core of the project. These will be assisted by one partner, 11 specialists, who are strongly linked to the Chinese environmental sector, and 28 supporting partners in Europe and five international regions: Russia, Belarus, China, Vietnam and Brazil. This shows that clean water is more than a European issue; it is a common concern of global magnitude.

The objectives of the Baltic Flows project have been designed to serve two top-level targets:

(a) to bring forth the technological and economic vision that will enable European regions to achieve world-class excellence and a sustainable competitive edge in the rainwater monitoring and management sector; and
(b) to fulfil the objectives of the coordination, enhancing the effectiveness of research-driven clusters in participating regions, and thus paving a smooth path towards smart specialisation, via a common trans-regional vision, strategy and realistic implementation plan.

In order to achieve real-world results, item b must follow item a; global competitiveness must be the first priority, as there is no point in interregional collaboration if the regions lack the prerequisites for potential competitiveness.

The work plan of the Baltic Flows project is designed to effectively facilitate different types of project activities carried out during the course of the project. Activities fall into four different categories: coordination and communication, network building, insight building in specific S and T area, and result consolidation. Coordination and communication work packages are essential to ensure that the fundamental goals of the project are achieved: the project is implemented as planned, and results are delivered in a manner beneficial to the European community.

The following Baltic Sea riparian states are involved in the Baltic Flows project: Finland, Sweden, Estonia, Latvia and Germany. A partner from the UK completes the partnership. The project is coordinated by the University of Turku in Finland.

1. University of Turku, Finland
2. Turku University of Applied Sciences, Finland
3. Turku Science Park Ltd., Finland
4. Regional Council of Southwest Finland V–S, Finland
5. Tallinn University of Technology, Estonia
6. Cleantech Estonia NPO, Estonia
7. City of Tallinn, Estonia
8. Hamburg University of Applied Science, Germany
9. Institute of Physical Energetics, Latvia
10. Environmental Projects Ltd., Latvia
11. Riga Planning Region, Latvia
12. University of Uppsala, Sweden
13. Upwis AB, Sweden
14. Uppsala County Administrative Board, Sweden
15. EcoTech International Ltd., UK.

Several organisations from Finland, Sweden, Estonia, Latvia, Germany, Russia, Belarus, China, Vietnam and Brazil provide input as supporting partners.

2.2 Project 2—AFRHINET

The AFRHINET project is a capacity-building project under the framework of the African, Caribbean and Pacific (ACP) Science and Technology Programme, which is funded by the European Union (EU) and implemented by ACP Secretariat.

The overall objectives of AFRHINET are twofold: to foster endogenous and self-replicable capacities in the field of RWHI management and sustainable dryland agriculture on one hand, and to boost the transfer and the adoption of research results by implementing research and technology-transfer activities and demonstration actions of innovative RWHI management on the other. This is expected to ultimately lead to improved food and water security, poverty alleviation, and socio-economic and climate resilience. The specific objectives of this project are as follows:

- To foster science and technological (S and T) capacities on RWHI, the quality of research and the capacity of the S and T communities to attract funding in this field of knowledge;

- To set-up a market-oriented research and technology-transfer framework to better capitalise and disseminate innovative research results;
- To develop the capacity of the S and T community and local communities to practically implement adequate RWHI management;
- To strengthen the link of S and T communities with the regional market, businesses/micro-enterprises, NGOs, policy-making actors and local communities;
- To establish a long-term ACP-EU network on RWHI management.

The capacity-building activities, and the transfer and demonstration of innovative RWHI management technologies envisaged under the framework of this project aim to stimulate the development and use of rainwater harvesting as a supplemental irrigation technology. This is expected to increase agricultural yields and foster the diversification of local income-generating activities for smallholder farmers through sustainable dryland agriculture, agroforestry and horticulture.

Furthermore, the AFRHINET project addresses gender equality and equal opportunities by taking into account the particular needs of women, tribes and minority groups during the design of the capacity-building courses. Efforts are being made to respect gender and ethnic balance in the project teams and in the number of participants/speakers in the capacity-building activities. AFRHINET's activities are developed combining the experience, innovations and best-practices available in eastern and southern Africa, with the concrete needs of the local context through participatory approaches, thus leading to actions that best fit the project, and results for the target countries.

In order to achieve the project objectives most efficiently, the AFRHINET project revolves around 5 groups of activity:

- Baseline study on the needs, potential and market-oriented products in the field of RWHI management
- Developing capacities on RWHI management for sustainable dryland agriculture, improved food security and poverty alleviation
- Research and technology-transfer centres on RWHI and sustainable dryland agricultural water management
- Building food, poverty and climate resilient communities: demonstration of innovative RWHI practices
- Networking, dissemination, promotion and awareness

The main outputs of the AFRHINET project are as follows:

1. Better support for the management, innovation and quality of applied research activities in the field of RWHI management for improved food security and poverty alleviation;
2. In-depth understanding of the market, as well as non-governmental, public sector and local community needs for RWHI management;
3. Reinforcement of the technical capacity to practically implement and adopt adequate and innovative RWHI management;
4. Improved market orientation of technology transfer for better capitalisation and dissemination of innovative and effective research, know-how and technologies;

5. Increased networking capacity of the S and T community with target groups and key national and international stakeholders;
6. Awareness, dissemination and promotion of RWHI and sustainable dryland agriculture management for improved food security and poverty alleviation.

The implementation methodology bears reference to achieving both long-term impacts (i.e. expertise development, transfer and adoption of research results and innovation, market-oriented science, networking, food and water security improvement and poverty alleviation) and short-term impacts (staff capacity-building, pilot and demonstration actions, a platform to network/transfer/adopt research results, etc.). Moreover, the implementation of the AFRHINET project aims at the close involvement and participation of the local stakeholders and target groups (NGOs, businesses/micro-enterprises, consultancies, public bodies and ministries, local communities, etc.) thereby important contacts to future clients and cooperation partners for research, transfer and adoption of science and technology activities will be built-up and deepened. These are vital for the successful implementation of innovative market-oriented actions in the field of RWHI and sustainable dryland agriculture.

The AFRHINET project is coordinated by the Research and Transfer Centre "Applications of Life Sciences" at Hamburg University of Applied Sciences (HAW), in Hamburg (Germany). The partner members of this project are as follows:

- Addis Ababa University, Ethiopia;
- University of Nairobi, Kenya;
- Eduardo Mondlane University, Mozambique;
- University of Zimbabwe, Zimbabwe.

The associate members of this project are as follows:

- International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Zimbabwe;
- Southern and eastern Africa Rainwater Network/International Centre for Research in Agroforestry (SEARNET/ICRAF), Kenya;
- WaterAid Ethiopia, Ethiopia.

The cross-sectorial cooperation generated within this project is expected to increase the awareness and mutual understanding on the importance of qualified human resources in sub-Saharan Africa and ACP countries. In addition, these activities are also expected to strengthen the role of sub-Saharan Africa and ACP countries as producers and distributors of information, know-how and technologies. This is expected to strengthen their role as hubs of knowledge for businesses/micro-enterprises, NGOs, public institutions and policy makers as well as to enhance the environmental and technological expertise available for policy-making, integration and innovation actions. Ultimately, this may lead to a solid basis for future projects and regional development.

3 Some Areas to Look at Now and in Future

As the two projects have shown, there are some practical dimensions to sustainable water use and management. Attempts to pursue it should consider a set of economic, policy and technological instruments. These are as follows:

(a) **Water pricing and metering**

Experts see water pricing as an essential requirement for sustainable water use and management. Water prices and tariffs must internalise all external factors, including environmental and resource costs (Werner and Collins 2012). Therefore, the Water Framework Directive obliges the Member States to take account of the costs of water-related services, this would allow the environmental costs of water to be reflected in the price of water (EEA 2012b, 2014b). Thus, water services with a negative environment impact, such as pumping, weirs, dams, channels and supply systems, will be paid for by the users (e.g. agriculture, hydropower, households and navigation), based on the polluter pay principle (EEA 2014d). However, solely, full-cost pricing is not a sufficient condition for sustainable water use (Bithas 2008).

The effectiveness of the implementation of the mechanism directly depends on the volumetric pricing and metering tool, a lack of which can lead to consumers being charged a fixed amount regardless of their actual water use (Bithas 2008; Werner and Collins 2012). An example of the successful implementation of the tools is the decline in public water supply in eastern Europe since the early 1990s (EEA 2009). However, despite the legal requirements under the WFD, such practices still are not used to their full extent, including agriculture water use (European Commission 2012; EEA 2014d).

(b) **Reducing losses due to leakage**

The reduction of leakage in water systems is another possibility for increasing water-use efficiency. The problem is relevant for both Eastern and western European countries. In addition, the situation in some countries, for example in Latvia, is aggravated by not sufficiently developed centralised water supply and sanitation systems (Visockis et al. 2010).

Leakage in public water systems is a common problem that results in loss of drinking water, wasting of energy and material resources used in abstraction and treatment, and a potential risk of bacterial contamination from surrounding ground (Werner and Collins 2012). According to various studies, leakage is usually the largest component of distribution losses, which range between 5 and 8.5 m^3/km of a pipe in the supply network per day (m^3/km/day) (Werner and Collins 2012; EEA 2014c). Only in Germany, Denmark, France and Sweden, average values range from 1 to 10 m^3/km/day (EEA 2014c). Although entire elimination of leakage is an unrealistic goal, leakage reduction is a crucial part of sustainable water management (EEA 2014b).

(c) **Information and communication**

Available, reliable and up-to-date information is another tool for sustainable water use and management. It has a lot of benefits including an improved overview of the causes, location and scale of water stress, identification of trends, facilitation of the evaluation of measures implemented to address unsustainable water use and further engagement of citizens—in Europe and elsewhere—in water issues (EEA 2009).

Awareness-raising campaigns aimed at domestic and business water consumers play an important role in water conservation (Werner and Collins 2012). Over the past 10 years, the amount of information provided to consumers and agriculture regarding efficient lawn-watering and gardening practices, water conservation, water-use behaviour, water-efficiency labels for households' appliances, etc. has significantly increased (EEA 2014d).

(d) **Technical measures**

Technical measures such as installation of water saving devices, reuse of grey water and treated wastewater, and rainwater harvesting might also potentially reduce the use of publicly supplied water. For example, installation of water-efficient showerheads can save about 25 L per property per day (Waterwise 2010 in Werner and Collins 2012). Stored grey water (wastewater from baths, showers, washbasins, kitchens and washing machines) can be subsequently reused for flushing toilets and watering gardens (Werner and Collins 2012). This might have a significant impact on an amount of water used by households that typically accounts for 60–80 % of the public water supply across Europe with personal hygiene and toilet flushing that amounts to about 60 % of this share (EEA 2009).

(e) **Rainwater harvesting**

As shown in the projects Baltic Flows and AFRHINET, rainwater harvesting (RWH) can be an effective tool. It refers to the process of collecting, diverting and storing rainwater from an impervious area, such as roofs, for subsequent use (EEA 2009). It can reduce use of treated public water by households and load on urban drainage systems during heavy precipitation (Werner and Collins 2012).

The size of a rainwater harvesting system and amounts of collected water might vary significantly. There are three major types of RWH: firstly, in situ RWH: collection of the rainfall on the surface where it falls and storing in the soil; secondly, domestic RWH: water which is collected from roofs, street and courtyard run-offs; thirdly, external water harvesting: the collection of run-off originating from rainfall over a surface elsewhere and stored offside (Helmreich and Horn 2009). Water may be used for flushing toilets, watering gardens and roofs with vegetative cover, and for the replenishment of a vegetated pond (Villarreal and Dixon 2005).

Rainwater is also a means for creating green urban areas. A conventional storm system of underground pipes is substituted by surface-water drainage system designed as open channels along the street collecting water from adjacent rooftops and paved areas. One of the examples of such system is a water park in the Enköping (Uppsala, Sweden). The project was launched by local council in 1995 (Wlodarczyk 2007).

In Latvia, the use of rainwater is in the frame of the strategic aims of the country: “Careful using of nature resources and safe for next generations”. The aims were established in order to follow the EU requirements regarding the decrease and optimisation of water and energy resources (Visockis et al. 2010).

In Poland, the cost of fully automatic rainwater harvesting system is relatively high in comparison with the average prices of the cubic metre of drinking water. An increase in usage of such systems in the country requires development of financial mechanisms such as subsidies and tax reliefs. Results of studies undertaken indicate that rainwater harvesting might cover between 30 and 40 %+ of the daily water consumption, depending on water consumption structure of that particular household (Mrowiec 2008).

The water use in agriculture requires special attention. One of the reasons is that on average globally, agriculture uses about 70 % of all freshwater withdrawals, out of which only 40 % contributes to crop production, whereas the remainder is lost (United Nations 2003). In some parts of southern Europe, a share of water used for the agricultural purposes reaches up to 80 % (EEA 2014a).

4 Conclusions

The sustainable use of water needs to be a top priority in the global agenda, especially in developing countries. Amongst the various technological and management measures available to increase the efficiency and sustainability of water use, the use of rainwater (project Baltic Flows) especially its use in irrigation (project AFRHINET) can play a key role. Across the European Union, potential water savings from improving conveyance efficiency are estimated at 25 % of water abstracted (WssTP 2010 in Werner and Collins 2012). In the developing counties, it can be even higher. The efficiency of irrigation depends on its type, for example, furrows, sprinklers and drip irrigation have 55, 75 and 90 % of efficiency, respectively (Werner and Collins 2012). However, rain-fed agriculture requires adequate mechanisms to reduce inherent risks (de Fraiture and Wichelns 2010).

Another measure is modification of agricultural practices, in other words, the selection of less water-intensive crop types as well as development of potential for returning irrigated land back to traditional rain-fed practices (Werner and Collins 2012).

The problem of illegal water abstraction, particularly from groundwater and often for agricultural purposes, is widespread in certain areas of Europe. This problem represents a major political and technical challenge (Werner and Collins 2012).

The next step in the European Union’s efforts towards sustainable water use and management is presented in the “Blueprint to Safeguard Europe’s Water” communication (European Commission 2012). The document includes reviews of the Water Framework Directive, Europe's policies on water scarcity and drought, and the water-related aspects of climate change adaptation and vulnerability. It is expected to help better integration of water objectives into EU policies and encourage water efficiency (EEA 2012a). Additional main documents in future EU water policy are the EU Biodiversity Strategy 2020 and the EU Resource Efficiency Roadmap, which aim at the efficient use of natural resources in order to support sustainable growth (EEA 2012a).

These elements all illustrate the relevance of and the need for sustainable water use and management and show how much still needs to be done, so as to make the sound use of water a reality.

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