Developing a framework for supporting the implementation of integrated water resource management (IWRM) with a decoupling strategy

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Abstract

The rise of integrated water resources management (IWRM) in the global water policy discourse marks a fundamental shift in water management from the techno-centric, top-down, supply-oriented and sectoral approach towards a holistic, participatory and demand-driven approach to sustainable water management. The IWRM concept has become dominant, permeating national, regional and international water policies, backed by heavy investments and advocacy by key global actors such as the World Bank and European Union. However, its implementation success remains unimpressive, amidst strong criticisms about its conceptual clarity. More recently, the decoupling concept spearheaded by the United Nations Environment Programme and Organisation for Economic Co-operation and Development is gaining momentum as an alternative approach for sustainable water management. This paper reviews the two concepts both acclaimed for organizing knowledge production for sustainability. The paper examines the underlying factors that limit IWRM implementation and assesses the potentials of addressing the inadequacies of IWRM with the decoupling concept. IWRM as a process lacks a clearly defined strategy, standard measures to track the success of IWRM plans and guidance for planning and project development, while decoupling offers a viable strategy that feeds into the implementation of IWRM plan, providing strategic and operational direction towards achieving sustainability goals.

Keywords: Decoupling concept; Framework; Implementation; IWRM; IWRM plan; Policy; Sustainability

1. Introduction

The search for a novel approach to address uncertainty and complexity surrounding water management problems prompted the rise of the concept of integrated water resource management (IWRM) over two decades ago. Since then, the concept has become a dominant discourse and assumed a

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paradigmatic place in water policies, owing to significant investment and international advocacy by powerful actors such as the World Bank and United Nations (UN). Despite the strong influence of IWRM in water policies and strategies in many countries, evidence to prove its implementation success and the highly acclaimed beneficial outcomes remain elusive. The IWRM implementation experience has not only drawn heavy criticisms, but many have questioned its definition and translation into practice. As implementation challenges continue and the concept becomes ordinary, questions emerge as to whether IWRM should be substituted, reinvented or left alone (Grigg, 2014). Replacing such a dominant concept appears impossible and costly following decades of massive investment and strong advocacy.

Recently, the concept of decoupling has emerged as a viable strategy to achieve sustainable rates of resource consumption and production for economic growth and social equity, while reducing environmental impact (Desha et al., 2012). The concept though new can boast of successful implementation outcomes in different sectors including the water sector (Fischer-Kowalski & Swilling, 2011). It stimulates rethinking about how improved human well-being connects with economic growth through sustainable resource consumption in ways that open up more creative options for innovation than before (Swilling, 2010). The concept has been criticized, with questions raised about its legitimacy, practicality and the compatibility of economic growth with conservation of finite natural resources (Jackson, 2011). Yet, suggested evidence of decoupling success in many countries makes the concept attractive as a suitable approach to managing water sustainably (Gilmont, 2014; United Nations Environment Programme (UNEP), 2014).

Being versatile with multi-functional abilities to address complex issues, both IWRM and decoupling have spurred lively, but mixed discussions about their meanings, interpretations, implementation and overall value-addition to sustainable water management. Decoupling has a strong scientific foundation in the theory of resource efficiency (von Weizsäcker et al., 2009), while IWRM has its roots in the theory of communicative rationality and the need to gain legitimacy through participatory processes (Saravanan et al., 2009). Despite their different origins, fundamental to the two concepts is the sustainability goal of increasing economic efficiency and improving social well-being, while minimizing environmental impact to sustain ecosystems’ integrity.

Based on a literature analysis, the paper reviews the concepts of IWRM and decoupling; interrogates their underlying assumptions, the theoretical foundations, different interpretations and criticisms; identifies the implementation challenges; and examines the potential of incorporating decoupling opportunities to help address IWRM flaws. The paper draws on the synergies between IWRM and decoupling concepts to develop a framework for sustainable water management with the aim to contribute to emerging knowledge as well as guide the implementation of robust water policies and innovative strategies that promote efficient water resource use and minimize environmental impact. The paper attempts to address three key questions:

- What does decoupling address that may help address flaws or inadequacies in IWRM?
- What are the synergies between the two concepts that can help in addressing complex water problems?
- How does the new framework contribute to achieving sustainable water resources management?

Following the introduction, Sections 2 and 3 explore the historical development of IWRM and decoupling approaches, their limitations, criticisms and evidence of implementation. Section 4 examines the
development of a new framework for sustainable water resource management. Section 5 presents the conclusion and areas of further research.

2. Origin and interpretations of IWRM concept

There is rarely common ground regarding the origin of IWRM. However, the 1977 Mar del Plata UN Water Conference marked a watershed moment in the history of water management, credited for the rise of IWRM to global prominence (Biswas, 2008). At the Dublin International Conference on Water and Environment and the Rio Conference on Environment and Development (Rio Earth Summit) in 1992, the IWRM approach was fully adopted leading to the establishment of global water institutions, including the Global Water Partnership (GWP) and World Water Council in 1996, to foster the ideals and conceptual development of IWRM. Over the next decade, the IWRM concept received high-profile endorsements at several international platforms. At the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, governments committed to develop ‘IWRM and Water Efficiency Plans’ by 2005. Several key actors, including the United Nations Development Programme (UNDP), Stockholm International Water Institute and the World Bank have since invested heavily in and promoted IWRM as the centerpiece of global water governance (Pahl-Wostl et al., 2008).

While the IWRM idea remains diverse, the often cited definition is the GWP definition of IWRM ‘as a process that promotes the coordinated development and management of water, land and related resources, to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems’ (GWP Technical Advisory Committee (GWP-TAC), 2000, p. 22). Three broad principles: multi-sectoral approach, stakeholder participation and decentralization, and the use of economic instruments inform contemporary IWRM. These principles are inspired by the Dublin water principles and comprehensively articulated in Agenda 21 of the Rio Earth Summit, which seek to achieve social equity, economic efficiency and environmental sustainability in water use.

Contemporary knowledge interprets IWRM within the context of integration. Several dimensions of integration have emerged within natural and human system perspectives to convey the meaning and functional abilities of IWRM. Within a natural system, integration implies the coordination of water management and use of all the elements of the natural hydrological system at basin level (Cardwell et al., 2006). Integration within the human system occurs among diverse stakeholders, institutions and sectors engaged in the development and management of a particular water resource. It also involves the coordination of a range of human activities and institutions to bring water resources into development planning, thus facilitating cross-sectoral integration of policies and strategies and all relevant stakeholders in the decision-making process (Fischhendler & Heikkila, 2010). The integration of multiple components offers a broad dimension for IWRM implementation, raising questions about the kinds of integration required in water management process. Biswas (2004) argues that such a wider view of integration in IWRM implementation may result in operational difficulties and end up complicating the problems rather than solving them.

2.1. Fundamental assumptions and theory underlying the IWRM approach

Underlying the contemporary IWRM concept is Habermas’ critical theory of communicative rationality, which advocates for a collaborative model of decision-making to achieve the wider democratic
society (Murray, 2005; Saravanan et al., 2009). He argues that through consensus, cooperation and reasoned argumentation, actors can build common understandings and coordinated actions rather than self-interested strategic action (Habermas, 1984). Informing this theory is ‘the unconstrained, unifying, consensus-bringing force of argumentative speech’, inherent in human social life (Habermas, 1984, p. 10). This force of argumentative speech is rooted in the stakeholder participatory principle of IWRM. Habermas’ perspective assumes an ‘ideal speech situation’ logic, which brings all stakeholders on an equal platform without exclusions or power asymmetries and with the strong belief that it can lead to a consensus through mutual and cooperative agreement. This logic behind the communicative aspect of IWRM appeals to policymakers (Saravanan et al., 2009). His argument presupposes that, in a communication action process, actors have equal knowledge and required skills to communicate and negotiate their power differentials with honesty and integrity. However, critics feed on the abstract nature of his assertion and argue for a more realistic and context-specific analysis. Murray (2005) argues that the communicative rationality ideology is constrained by its failure to consider the impact of external forces and power inequalities in shaping decisions and outcomes.

2.2. IWRM criticisms

Despite the high relevance of IWRM principles in contemporary water management, its implementation has drawn more criticism than praise. The World Bank, a strong advocate for IWRM, even concedes that its beneficial impact has been insignificant (Blomquist & Schlager, 2005). For some authors, the main barrier to successful IWRM implementation is the lack of theoretical and conceptual clarity (Biswas, 2008; Saravanan et al., 2009). Grigg (2014) argues that the concept is vague and characterized by an all-inclusive character and flexibility, which makes it a ‘convenient target of opportunity’ (Grigg, 2014, p. 413). Molle (2008) describes IWRM as a ‘nirvana concept’ or idealistic model that seeks to harmonize and achieve multiple desirable, but conflicting, goals simultaneously. The harmonious agenda of IWRM tends to obscure the intrinsic political nature of water resources management (Allan, 2003; Mollinga, 2008). In reality, IWRM is conflict-loaded and a politically contested process with water control and allocation at the heart of management (Allan, 2003; Saravanan et al., 2009). In highlighting the political nature of IWRM, Allan redefines IWRM as Integrated Water Resource Allocation and Management, focusing on ‘allocation’ as the key political locus of water resource management (Allan, 2003). In water-scarce contexts, the inevitable conflictual nature of water allocation between competing uses and users legitimizes existing powers and rights inequalities among stakeholders (Allan, 2003). Such conflicts and illegitimacy of power embedded in water allocation serve as major impediments to IWRM implementation.

2.3. Evidence of implementation of IWRM principles

The permeation of IWRM principles in national, regional and global policies and programs has been remarkable. However, translating these principles into practice has mixed outcomes. The recent assessment by UN-Water, United Nations Environment Programme (UNEP), UNDP and GWP focused on the progress made by countries in the development of IWRM plans and implementation of the various elements of IWRM following recommendations by the Johannesburg Plan of Action (UNEP, 2012). The report indicated that, out of 134 countries surveyed, about 50% had made ‘significant progress’ in developing IWRM plans, and are at an ‘advanced stage of implementation’ (UNEP, 2012, p. 13).
The report admittedly concedes that implementation of IWRM plans has been slow and in some cases stalled, particularly in developing countries due to weak institutional structures, low enabling environment, lack of financing, and management instruments (UNEP, 2012). In creating an enabling environment, most countries (82%) have modified their water laws to reflect integrated approaches to water resources development and management. About 79% have embraced IWRM tenets into their water policies, even though translating policies into action remains a slow process. In establishing governance and institutional frameworks, about 71% of countries surveyed carried out institutional reforms with the aim to legitimize and enhance stakeholder participation. However, the reform process has been slow. Over 84% of developed countries and 40% of other countries have applied management instruments such as demand management, allocation systems, groundwater management, etc. Over 65% reported improvement in infrastructure development such as water supply and hydropower infrastructure. There is, however, a weak positive correlation between putting in place an enabling environment for an integrated approach and progress with infrastructure. Slightly above 50% of developing countries reported a growing trend for government budgets and donor assistance in developing and managing water resources. Revenue mobilization from water management slightly improved in many countries although still far from expectation particularly on payment for ecosystem services, where the available data indicate limited progress.

Several case studies reported by the GWP as IWRM implementation in different countries revealed a broad range of scenarios and varied interpretation of IWRM at different levels (local, national, transboundary, etc.). In Swaziland, an IWRM case shows community-level engagements of four communities in collaboration with national and traditional authorities on a local dam with unclear ownership (GWP, 2013). A case in Morocco depicts awareness creation among water users on improving efficiency, private sector engagement in water supply, and demand management of groundwater in the coastal areas of Rabat and Casablanca (GWP, 2013). In Bangladesh, the implementation of a 25-year National Water Plan now recognizes the role of water for social justice, equity and poverty alleviation in a centralized, heavy engineering water system which was initially purposed for flood control and irrigation (Rasul & Chowdhury, 2010). In Europe, three IWRM cases in France, Germany and the Netherlands show the central role of stakeholders’ interaction in the use of innovative instruments and institutions to support the implementation of the European Union’s Water Framework Directive (GWP, 2013). Such a widely divergent range of applications of different aspects to varied contextual situations often implicates IWRM as far too wide and accommodating, raising fundamental problems of ambiguity in integration, and lacking clear guidelines and strategies for implementation (Grigg, 2014).

3. The concept of decoupling

The contemporary decoupling concept, applied in natural resources was coined from the term ‘eco-efficiency’, promoted by the World Business Council for Sustainable Development in 1992. However, decoupling was first highlighted in the Organisation for Economic Co-operation and Development (OECD)’s ‘Environmental Strategy for the First Decade of the 21st Century’ as a major objective for sustainable development in 2001 (OECD, 2002). Since then, the concept has received implicit or explicit emphases in several environmental discourses globally. At the WSSD, stakeholders recognized the necessity to decouple economic growth and environmental degradation by improving efficiency of resources use and production, and reducing resource pollution and waste (Woods, 2010). The European
Union (EU) recognizes decoupling in its ‘Thematic Strategy on the Sustainable Use of Natural Resources’ under the 6th Environmental Action Program (EAP). The UN Economic Commission for Latin America and the Caribbean strategy to promote a ‘non-material economic growth’ agenda reflects the decoupling notion to achieve sustainable development in Latin America and the Caribbean countries (Fischer-Kowalski & Swilling, 2011). The decoupling concept features prominently in Africa’s strategy for sustainable development pathway and structural transformation (United Nations Conference on Trade & Development (UNCTAD), 2012).

Recently, UNEP established the International Resource Panel (IRP) to provide scientific impetus and produce knowledge on the decoupling concept. The IRP defines decoupling as ‘reducing the amount of resources such as water or fossil fuels used to produce economic growth and delinking economic development from environmental deterioration’ (Fischer-Kowalski & Swilling, 2011, p. 4). Decoupling seeks to achieve sustainable patterns of resource consumption and production while maintaining the integrity of the natural environment (Figure 1) (UNEP, 2011). It consists of resource decoupling and impact decoupling. Resource decoupling is based on reducing the rate of resource use per unit of economic growth (‘doing more with less’). Impact decoupling occurs when negative environmental impact from resource extraction declines while adding value in economic terms (Fischer-Kowalski & Swilling, 2011). Both resource and impact decoupling can occur in ‘absolute’ or ‘relative’ terms. Absolute decoupling represents a decline in both aggregate resource input and environmental impact over time while economic growth continues. Relative decoupling occurs when resource consumption and environmental impact still grow, albeit slower than the economic growth rate (ibid).

According to Haberl et al. (2004), decoupling establishes three relationships between economic growth, resource use and environment. These include: (1) decoupling economic growth, e.g. measured by gross domestic product (GDP) growth, from water throughput (increased ‘efficiency’ leading to ‘dematerialization’), (2) decoupling water throughput from environmental impact (‘environment’), and (3) decoupling economic growth from human well-being (‘equity’). Decoupling offers a country the opportunity to achieve greater economic value out of fewer resource inputs (material and energy) per unit value (UNEP, 2014). In illustrating the degree of decoupling, Fischer-Kowalski & Swilling (2011) established the decoupling index (DI), a single indicator which assesses the ratio of change in rate of a resource consumption or rate of producing pollutant emissions to the change in economic growth rate within a certain period. With continued economic growth, the DI may suggest any of the

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**Fig. 1. Conceptualizing decoupling.**
following three scenarios that align to the Environmental Kuznets Curve (EKC) in Figure 2 (Fischer-Kowalski & Swilling, 2011):

- **Coupling** – when the rising rate of water consumption or pollution keeps pace or increases with a growing economy \((DI \geq 1)\) as illustrated by the ‘climbing stage’ of the Curve (Area A). Here, water consumption and environmental degradation increase rapidly as the economy grows. When \(DI = 0\), it means the economy is growing while resource consumption or amount of pollutants remains constant.

- **Relative decoupling** – when the rate of water consumption or pollution grow albeit slowly with increase in economic growth rate \((0 < DI < 1)\) (Area B). When DI ranges from 0 to 1, lower DI means higher resource efficiency and lower dependence on water resources.

- **Absolute decoupling** – when the economy grows while water consumption or pollution remains constant or even decreases \((D \leq 0)\). Here, the relationship between environment and economy is described as the ‘declining stage’ of the Curve (Area C).

These decoupling scenarios seem to coincide with countries’ development levels and socio-economic patterns, especially the consumption trends. In developed countries, water consumption has gone beyond the peak of the EKC where consumption is decoupled from economic growth and environmental pollution facilitated by innovations and technologies. Most developing countries are still at the early stage of the curve where water use and economic growth are still coupled. These countries are currently locked in water-intensive activities, with a certain level of inevitable environmental degradation bound to occur. Such a development trajectory aligns with the ‘grow first, clean up later’ principle, a notion that situates economic growth at the root of environmental harm (Dasgupta et al., 2002). However, several scholars have questioned this notion, whether countries can effectively ‘grow’ their way out of environmental degradation (Stern, 2004; Caviglia-Harris et al., 2009; Mills, 2013). The decoupling outcomes based on the Kuznets curve have come under strong scrutiny, particularly the relationship between water use and economic development (GDP). For example, Duarte et al. (2013) acknowledge the existence of EKC relationships between water use and GDP (in per capita terms), but argue about the

![Fig. 2. DI based on the EKC (adapted from Fischer-Kowalski & Swilling (2011)).](https://iwaponline.com/wp/article-pdf/18/6/1317/403622/018061317.pdf)
weakness of such relationships, making the EKC a poor predictor of national level patterns. Likewise, Katz (2015) supports the idea of the EKC relationship between water use and economic variables, but argues that the evidence remains weak and strongly dependent on data used and statistical method applied, concluding that the value of EKC for water policy planning is limited. Sušnik (2015) strongly disputes the EKC, arguing about the absence of discernible relationships between GDP-per-capita and any water-related metric (including water withdrawals per capita, total national water withdrawals and agricultural water withdrawals). Though these studies are useful in defining relationships between resource use and economic indicators, they tend to focus mainly on economic issues, leaving the aspect of environmental impact. In sum, the EKC relationships for decoupling depend on multiple variables including dataset types, statistical methods, assumptions regarding functional forms, and the choice of water usage metrics chosen as a dependent variable, among others.

On the other hand, UNEP (2014) proposed two decoupling types, namely decoupling through a maturation process, thus a shift from an extraction and production-based economy towards a service-driven economy, and ‘burden shifting’ or externalizing environmental costs through virtual water trade, that support the notion of EKC for local environmental degradation. However, virtual water fails to account for hidden inflow and environmental impact resulting from water-intensive production activities at the products’ origin. Debate continues among scholars as to whether virtual water trade is really a smart water saving mechanism or about the moral implications of shifting environmental burden elsewhere or the risk of increasing reliance on other nations and reducing food self-sufficiency and resilience (Hordemann & Neubert, 2007). Chapagain & Hoekstra (2008) argue water trade between nations has the potential to significantly improve global water use efficiency, enhance water security in water-scarce regions and overcome global and regional imbalances in water availability. For Gilmont (2014), the advantage of closing the gap between national water supply and demand makes virtual water trade quite attractive for water-scarce nations. Nonetheless, caution must be taken in promoting virtual water trade as a water-saving mechanism for decoupling, given that the environmental cost and political risk might overshadow improved water use efficiency outcomes. Developing countries with severe water scarcity may lack the financial means to engage in virtual water trade and may not afford to import low-value high water intensity (food) crops. In order to be viewed as a means of using international and regional trade to pursue sustainable water resource management, virtual water trade must also take into account the social and environmental values of water.

3.1. Evidence of water decoupling success

Empirical cases of decoupling success are recorded in several cities and countries worldwide. At the city level, the city of Windhoek, Namibia, implemented a water decoupling strategy that accounted for a reduction in residential per capita water demand from 201 to 130 litres per day (Magnusson & van der Merwe, 2005). In Brisbane, Australia, there was a 50% per capita reduction in potable water use from 2005–2010 through highly cost-effective investments in water efficiency and demand management. The outcome/result is the significant increase of economic return from AU$50 million to AU$95 million per gigalitre (GL) of water. At the national level, Australia reduced water consumption by about 40%, while GDP grew by over 30% from 2001 to 2009, with the agricultural sector reducing water use from 12,200 to 7,000 GL between 2004 and 2009 (UNEP, 2014). Singapore’s economy grew 25-fold, while the population increased by a factor of 2.5 to 4.4 million people over the last 40 years. Yet water use has only increased five-fold or a two-fold per capita increase (Khoo, 2009). In other words, the average
home in Singapore now consumes four times less water than a US home of comparable income (UNEP, 2014). The improved efficiency and reduction of wasted water has permitted Singapore to significantly cut down water import from Malaysia by 60%, with plans on course towards zero water imports (Khoo, 2009). In Israel, with the adoption of drip irrigation, freshwater use in farming has significantly reduced by 50% since 1984, while production has continued to rise. Israel also has a rich experience of wastewater reuse for irrigation purposes. Out of the 467 million cubic metres per year of wastewater collected, 395 Mm³/y (about 84%) is reclaimed mainly for irrigation purposes (Hoffman et al., 2005).

From the cases presented, the outcomes from implementing decoupling water strategies may not necessarily be an immediate or one-off event. Evidence of decoupling outcome has been described as a process of incremental sequence (Gilmont, 2014). Achieving decoupling obviously requires time, and may not even be politically or economically feasible. However, cases of decoupling success, were not an automatic by-product of national GDP growth, but the result of conscious efforts through political commitment, policies, structural transformations and investments in technologies and innovations.

3.2. Decoupling criticisms

Jackson (2011) describes decoupling as a myth, arguing that decoupling relies on false statistical trends to make its case. Other scholars have questioned the feasibility of reducing resource consumption and environmental impact to a sustainable and reasonable level in the context of continuous economic growth (Ehrlich et al., 2012). Fell et al. (2010) noted two arguments surrounding decoupling, first, the legitimacy of decoupling as an appropriate concept and the compatibility of economic growth with conservation of finite natural resources, and second, the feasibility of decoupling in practice and the lack of formal evidence. Critics of economic growth have argued that relative decoupling has always characterized industrial economies, referring to outsourcing the production of consumer goods and services to developing countries where the actual resource use and emissions occur (Walker, 2013). For absolute decoupling, some argue that evidence is less common or that absolute decoupling is virtually impossible (Jackson, 2011).

4. IWRM implementation flaws and decoupling opportunities

The principal concern for proponents of IWRM is to get the iterative process ‘right’ (Jønch-Clausen, 2004). The assumption is that, when the fundamental enablers are established and the various components in the process are effectively functioning, IWRM goals would be achieved. And so the contemporary IWRM process has mainly focused on building governance systems by establishing or strengthening the key areas deemed relevant to/form the implementation of the IWRM plan. In the recent global IWRM status report, countries reported their performance on reforms in policies, regulations and institutions; development of IWRM plans, capacity building, stakeholder participation and financial investment in water infrastructure in countries, but failed to report on the achievements in water efficiency, social equity and environmental sustainability (UNEP, 2012). There is a high tendency to neglect a very essential component of the process, the IWRM plan, by focusing on the process. The implementation of the IWRM plan remains a challenge for several countries due to the ambiguity in the application of appropriate management instruments, measures and tools to operate in specific contexts. In its 2011 policy statement, the American Water Resources Association noted that IWRM
‘suffers from a lack of clear definition, the lack of standard measures to track the success of IWRM plans and projects, and the absence of guidance for those involved in planning and project development1.

Decoupling offers strategies that would feed into the implementation of IWRM plans, providing strategic and operational direction towards achieving sustainability goals. Increasing resource efficiency and resource productivity are two key enablers of decoupling. Resource efficiency creates more socio-economic value using the least resource input, minimizing waste generation and environmental impact at every stage throughout the resource life cycle (extraction, production, distribution, consumption and disposal), thus improving resource productivity (Umpfenbach, 2013). Although used interchangeably, resource ‘efficiency’ targets a system’s optimal state with greater micro-level focus while ‘productivity’ focuses on the macro-level. In the domestic sector, improvement in water efficiency means reducing water losses resulting from leakages in supply systems, wastage use of water, etc. In the industrial sector, dealing with leakages, recycling and reuse of water can substantially improve efficiency. In the agricultural and industrial sectors, decoupling reflects improved water use efficiency with highly efficient drip irrigation systems, and increased reuse of recycled water for irrigation, agro-processing and industrial cooling (Chenoweth et al., 2013). However, there is a risk that gains from efficiency and productivity can partially be offset by increased production and consumption of the same good or service (direct rebound effect) or of a different good or service associated with resources use (indirect rebound effect) (Walker, 2013). Therefore, technological advances and policy measures for decoupling must take cognizance of these undermining side-effects.

4.1. Towards a framework for supporting IWRM implementation with decoupling strategy

A sustainable world demands continued efforts towards developing ways for practicing sustainability in the management and planning of resources and society. The sustainability agenda prioritizes the fulfilment of society’s needs in an equitable (socially desirable) way, to create a viable economy with costs not exceeding income (economically efficient), and to maintain a long-term environmental viability (ecologically bearable) (Adams, 2006). These elements form the pillars of sustainability. The sustainability goal provides desired outcomes for water managers, stimulates a thinking of resource perpetuity, the water use cycle and its implications on environment. Both IWRM and decoupling concepts are regarded as key concepts that promote sustainability.

As the search for innovative ways to address sustainability challenges in water resource management continues, the paper lays out a framework that synergizes the essential elements of IWRM and decoupling concepts to understand the dynamic interactions among social, economic and ecological processes that facilitate the pathway to sustainability, taking into account political factors, and institutional and governance requirements (Figure 3). Synergies in integrated and decoupling approaches have the potential to achieve sustainability goals better than the independent approaches.

The sustainability framework is carried out with the view to develop a system that recognizes the interdependencies among isolated water resource management elements, and build the linkages to generate multiple benefits and well-being while utilizing water resource sustainably. Highlighted in the framework is the focus on the process to facilitate integration, and on the goal to achieve sustainability through decoupling enablers, mainly resource efficiency. The first part of the framework entails the

1 www.awra.org/policy/policy-statements-IWRM.html.
step-by-step cyclic process which includes six iterative stages: Diagnosing; Visioning; Strategizing; IWRM plan; Implementing and Monitoring and evaluating.

- **Stage 1: Diagnosis** – Involves assessing the current situation of water resource issues, and identifying and recognizing the problems, threats and opportunities.
- **Stage 2: Visioning** – Stakeholders assess the problems, their causes and impact, and then develop a future vision that addresses the problems of water resources management.
- **Stage 3: Strategizing** – Based on the diagnosis and vision in the previous stages, stakeholders initiate the development of scenarios and suitable strategies through consultations and dialogue. These scenarios and strategies are evaluated to identify the best strategies for achieving the vision.
- **Stage 4: IWRM plan** – Following the evaluation of the scenarios and best strategy, an IWRM plan is developed. The plan envisages how the change will be achieved to reflect the sustainable water management principles. It details the roles and responsibility, schedule, budget, targets to be achieved and indicators for monitoring and evaluation.
- **Stage 5: Implementation** – The plan is endorsed and implemented by government in a coordinated way. The approval of stakeholder, government and external financial support for programs and budget are key factors to speed up the implementation of the plan (UN Department of Economic & Social Affairs (UNDESA) & GWP, 2006).
- **Stage 6: Monitoring and evaluation** – Stakeholders assess the progress made in the implementation of the plan in line with planned budget and responsibilities. Extensive public consultation and active stakeholder involvement provide feedbacks and lessons in implementing the plan and for determining whether it is necessary to adjust the original plan or repeat certain stages of the process.

Fig. 3. A new framework for sustainable water management (adapted from UNDESA & GWP (2006) and Tan et al. (2013)).
The iterative process promotes the engagement of multiple stakeholders and government. For effective implementation of the IWRM process and plan, it is essential to create an enabling environment (e.g. policies and legislation), establish an institutional framework for implementing policies, strategies and plans (e.g., organizational structure and institutional arrangements), and to define management instruments (e.g., needs assessments, water efficiency measures, etc.) necessary for integrated management and planning (UNDESA & GWP, 2006).

The second part of the framework shows the strategy for the IWRM plan, which entails how decoupling approaches can be applied to improve water resource use efficiency and social equity, and reduce environmental impact. These include:

- The reduction in water input through demand management, behavioral change of users, and use of more efficient technologies and products. Influencing consumer demand and behavior by means of incentives and taxes has proven to be cost-effective rather than the costly approach of developing new sources of water supply. Essentially embedded in this approach is the decoupling principle of dematerialization, which implies the reduction in the quantity of water withdrawals.
- The reduction in water losses by fixing leakages in pipe supply networks, and installing efficient and advance leakage detection monitors. By addressing these problems, water supply to various users can be significantly increased by as much as 30–50%, particularly for developing countries where water losses through leakages account for up 50% of water supplied in the pipe system (Dighade et al., 2014).
- The reduction of waste in water use in the system which can contribute to reducing overall water resource demand, reducing the need for additional water inputs, and eventually leading to a more sustainable level of water resource withdrawals.
- Substituting water resources with other natural resources less harmful to the environment. For example, countries can shift towards the use of gas in the generation of electricity instead of relying on hydropower. This approach may directly result in reducing water resource inputs and free up water for ecosystem functioning.
- Ensuring that water resource withdrawals are kept within sustainable thresholds to allow water resource to replenish and to ensure the optimal functioning of the ecosystem to provide desirable services.
- Recycling wastewater through efficient technologies which can contribute significantly to reducing environmental impact and offer the chance for water reuse in water consuming activities such as industrial cooling, watering golf courses and flushing toilets (Brandes & Brooks, 2005).

Tapping into the potential of this framework creates a virtuous cycle that strengthens the economic, social and environmental pillars of sustainability, to help break the vicious cycle of water resource over abstraction, over-consumption and wastewater pollution; develop systemic sector coordination, collaboration and stakeholder interaction; encourage the adoption of sustainable technologies and innovative practices; incorporate water resource efficiency measures such as reuse, reduce and recycle strategies; and ensure sustainable livelihoods through equitable access to water.

This framework embodies a number of separated but interrelated principles that have a shared notion to achieve sustainability:

- Holistic approach – embracing an ecosystem approach and view to examine the interconnections among water issues (economic, social and environmental dimensions) at various scales;
• Integration – integrating water resources planning, management and governance (stakeholders, institutions, policies and sectors) across sectors and scales for a balanced approach;
• Collaborative and participatory decision-making – engaging stakeholders throughout the process to ensure ownership, accountability and transparency;
• Life cycle thinking – a perspective that considers sustainability over the entire life of the process; and
• Adaptive management – taking into account the uncertainties linked to increasingly complex and interconnected water issues, water resource management must be a dynamic process capable of adapting and responding to changing situations.

The framework provides an understanding not only about the trade-offs regarding water management goals such as water saving, economic development or environmental quality, but also the interdependencies and interconnections within the water management process. Such a framework is capable of addressing the issue of ‘rebound effects’ associated with increased water efficiency that may result from reduced relative cost of water per unit output and reduced absolute water price, which incentivize higher levels of consumption (UNEP, 2014).

4.2. Toward sustainable water management: drivers of action

Pursuing the sustainable water management goal through the application of this framework requires careful identification of drivers of action. An effective driver of action has the capability to inform change, dismantle vested economic interest of the powerful elite in the political process and circumvent capital-intensive infrastructural lock-ins that have characterized water management. These drivers of action include technology and innovation, social action and institutional change, capacity building, policy and regulation, and financial investment.

4.2.1. Technology and innovation. Water managers, among other stakeholders can benefit immensely from the application of existing and emerging technologies and innovations to reduce water input, increase efficiency of water use and reduce wastewater. For example, efficient technologies such as drip irrigation systems can save up to 50% of water compared to the conventional irrigation types (von Weizsäcker et al., 2009). Wastewater reuse is high on the agenda in countries across North Africa and the Middle East where water is very scarce. By using efficient technologies, 79% of sewage effluent is recycled and reused in Egypt, and in Israel, 67%, mostly for irrigation and for environmental purposes (Food and Agriculture Organization (FAO), 2010).

4.2.2. Strengthening the capacity of stakeholders. One of the critical barriers to sustainable water management is the lack of adequate knowledge and skills to implement innovative strategies and plans, to deliver desirable sustainability objectives. In this regard, focusing on knowledge and skills development of water managers and policy makers, among others, is an essential prerequisite for implementing interventions for promoting sustainable water resource management. The stakeholders would gain knowledge and understanding of the dynamic water management process, and acquire the skills needed for effective implementation of water management interventions.

4.2.3. Financial investment. Financial investment and finance structure are essential ingredients for driving the application of water technologies and innovations to support sustainable water resources
management. The lack of finance may compel water managers and stakeholders to implement ad hoc stop-start strategies rather than contributing meaningfully towards a long-term systemic process of achieving desired sustainability goals. A secure long-term financial availability for water management interventions has the potential to reduce risks associated with reactive projects due to piecemeal funding.

4.2.4. Social and institutional change. With existing water management practices producing unsustainable outcomes, transformation of current social and institutional configurations that influence the behavior and decision-making of stakeholders is necessary. Changes in consumer lifestyle through awareness creation, incentives, and institutional arrangements, along with strong leadership are critical in responding to the challenges linked to the transition towards more sustainable production and consumption patterns.

4.2.5. Policy and legislation. An effective policy provides an overall direction for change, with far-reaching influence on the functioning of water management institutions, efficiency of systems and consumers response to water use. For example, policy can provide a push factor for technology and innovation uptake, and change paradigms for what is socially acceptable to influence consumers to use a certain amount of resources sufficient for optimal health, well-being and happiness (Tan et al., 2013).

5. Conclusion

Efforts towards sustainable water management require dynamic measures that can support the development of optimal solutions to maximize water use efficiency and productivity, while facilitating economic growth that is decoupled from water resource depletion. The IWRM concept aims to transform water management processes to achieve economic efficiency, social equity and environmental sustainability in the water sector. However, evidence of successful implementation of IWRM in many countries remains mixed, while the concept lacks contextual and conceptual clarity. The decoupling concept offers a viable pathway for achieving the IWRM goals of improving social well-being and economic growth in a way that does not jeopardize the ecosystem’s ability to function effectively. This paper has illustrated how IWRM and decoupling share the common goal of sustainability, through achieving social equity, economic efficiency and minimizing environmental impacts to sustain ecosystems’ integrity. Synergies between IWRM and decoupling approaches that support water governance, water savings and closing water recycling loops could lead to sustainable water resource consumption, demand, and management of environmental impact. Theoretically, drawing synergies between IWRM and decoupling to establish a framework may seem quite easy, but in reality a number of trade-offs may arise in attempting to apply this framework. However, the framework builds on existing frameworks and raises an alternative option for addressing water management challenges in a complex, changing world. From a shared goal of environmental sustainability, the ultimate interest for the framework is to reduce water pollution and avoid subsequent degradation of ecosystems. From a socio-economic perspective, the deal is to head off the looming water scarcity crises by increasing water savings and enhancing water allocation through improvements in efficiency and productivity. The framework also offers a novel approach to guide decision-making and enhance knowledge production around sustainable water resource management. The wisdom in this framework lies in the
emphasis on the holistic processes, interactions and the goals to move towards sustainability in an iterative process, driven by effective policies and legislation, technology and innovations, social and institutional change, capacity building and financial investment.

5.1. Further research

In moving forward, a future study intends to examine how the new framework could be applied to attain the sustainable management of water resource drawing on cases in developing economies. The study would highlight strategies, practices and interventions that strengthen the case for a more dynamic approach toward sustainable water resource management. Key research questions that would be addressed include:

- What scale (local, national, river basin, trans-boundary, and global scales) is most suitable for the application of this framework to achieve maximum sustainability goals?
- How do existing local dynamics foster or limit the application of the new framework?
- How does the framework help in identifying challenges and optimal solutions for sustainable water resource management?
- What would be the indicators and metrics for assessing the application of the framework to achieve IWRM and decoupling goals?
- What lessons could be drawn from the application of the framework to inform policy decisions?

References


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