Ecohydrology: A management tool for aquatic ecosystem and SDGs implementation

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Abstract. The availability and quality of water resources are not only to support human health and well-being, but also are providing the functioning of essential ecosystems, including rivers, wetlands, lakes and coastal ecosystems. The contamination of the aquatic ecosystem certainly carries a substantial loss, not only for the environment but also for human beings who use the goods and services of the environment. Water related problems often cannot be managed and overcome completely because of sectoral approach, monodisciplinary and unintegrated. Transdisciplinary science dealing with the interaction of hydrological processes and the dynamics of biology and/or ecology in various spatial, temporal conditions and human life practices around its environment is called ecohydrology. The ecohydrology concept is agreed to solve water related problems in the world. It is included in one of UNESCO IHP VIII themes to support SDGs achievement. This article aims to demonstrate the concept of ecohydrology in supporting sustainable water resource management. Based on the implementation of ecohydrology concept in three different demonstration sites, the results showed that it has been agreed as the solution to improve and restore river basin and lake ecosystem functions and services. It is important to note that the implementation of ecohydrology should consider economic valuation, political and government support as well as local society involvement in order to get effective and sustainable solutions for managing water resources.

1. Introduction

Water is our most valuable natural resource. Five major issues related to the environment and water resources that challenge Asia and Pacific region are: weak of water and sanitation services, floods and droughts due to climate change, loss of biodiversity, increased potential for water conflicts and environmental pollution [1]. The availability and quality of water resources are not only to support human health and well-being, but also are providing the functioning of essential ecosystems, including rivers, wetlands, lakes and coastal ecosystems. Without the management of healthy water resources, human activities can disrupt the balance between water resources and environmental sustainability. Human pressure is high on the water body and its environment and increasing with the growth of population and economy in the Asia and Pacific region. Eighty percent of pollution in water bodies including marine pollution comes from land-based sources and, in developing countries, more than 90% of waste and 70% of industrial waste is discarded, untreated, to surface waters where they
pollute water supply and coastal waters with harmful consequences for biodiversity, human health and marine ecosystem services [2, 3]. In 2025 it is estimated that 75% of the world’s population, or 6.3 billion people, will live in a coastal zone, naturally, this will increase the pressure on water resources and reduce their sustainability. In addition, global changes affect the water ecosystem both from the soil (e.g., changes in hydrological cycles and rainfall patterns), and from the sea (e.g., change at sea level) [4]. With these conditions, concepts and methods are needed to address these impacts and provide solutions to sustainable water resources management in the future.

According to [5], ecosystems including water and coastal bodies have several functions: (1) regulatory functions, ecosystems have the ability to regulate essential ecological processes in nature; (2) habitat function where the ecosystem is a home or living place for plants and animals; (3) production function, ecosystems do photosynthesis to convert nutrients into energy and subsequently eaten by other biomass life, and; (4) information functions, the ecosystem provides a reference function and can be a source of place for relaxed, leisure and recreational enrichment. The function of the ecosystem further forms goods and services which are of benefit and economic value for human beings. The goods and services produced by the environment can be classified into 3 values: ecological value, socio-cultural value and economic value. Assessment of economic impacts due to environmental pollution can be approached by an economic valuation approach to comprehensively see the economic value of an area. Model of [5] covers all goods and services generated resources ranging from ecological, economic to socio-cultural. Resource economic valuation plays an important role in providing information to assist with public policy decision-making [6].

The contamination of the aquatic ecosystem certainly carries a substantial loss, not only for the environment but also for human beings who use the goods and services of the environment. Therefore, pollution must be remedied, and the damage must be rehabilitated to restore the lost functions. Nevertheless, the handling of pollution and rehabilitation of damaged environments requires a lot of cost. Failures in handling water related problems are often caused by sectoral, monodisciplinary and unintegrated approach. This article aims to see and demonstrate that the concept of ecohydrology, as a transdisciplinary science, can be used to reduce impacts and to prevent pollution to the aquatic environment to support sustainable water resource management.

2. Ecohydrology in the Corridor of Intergovernmental Hydrological Program (IHP)
IHP is the program of intergovernments under the United Nations system focusing on water resources management, water research, education and capacity building. Since its inception in 1975, the program covered many aspects from hydrological research into holistic program to: mobilize international cooperation; strengthen the science-policy interface; and facilitate education and capacity development in order to improve the management and governance of water resources [7]. Water Security is defined by IHP as: “The capacity of a population to safeguard access to adequate quantities of water of acceptable quality for sustaining human and ecosystem health on a watershed basis, and to ensure efficient protection of life and property against water-related hazards – floods, landslides, land subsidence and droughts.” In lining with the current Eighth Phase of IHP (IHP-VIII) focus theme on “Water Security: Responses to Local, Regional and Global Challenges”, IHP facilitates an interdisciplinary and integrated approach to sustainable watershed and aquifer management, including the social and economic dimensions of water [8]. This program supports actively the achievement of Sustainable Development Goals (SDGs) in different targets, directly or indirectly, such as among others: (2) end hunger, achieve food security and improved nutrition and promote sustainable agriculture, (6) ensure access to water and sanitation for all, (7) ensure access to affordable, reliable, sustainable and modern energy, (13) take urgent action to combat climate change and its impacts, (15) sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss. Comprehensive approach including problem identification, strategies planning and implementation need appropriate tools and methodologies in order to overcome water related problems. Strengthening scientific knowledge, research activities, systematic observation and best practices sharing will very helpful to support policy decision-making [8].
Since 1996, UNESCO IHP developed and formulated a new program called “Integrative Approach of Ecohydrology”, through a key theme of the fifth phase “Hydrology and Water Resources Development in Vulnerable Environment” [9]. Ecohydrology is defined as an integrative science studying the relationships between hydrological and ecological processes in soils, vegetations, rivers and lakes at the catchment scale. It deals with hydrological and ecological factors which determine the dynamics of natural and human-driven ecosystems and influence water dynamics and water quality. Simultaneous study of ecological and hydrological processes to enhance the overall integrity of aquatic ecosystems in the face of human-driven alterations and global change of a system is called “dual regulation” (Figure 1). River basins represent a suitable scale for integrated ecohydrological studies and modeling for the reason of a hierarchical structure and natural boundaries, and can be considered as inherent integrators of the effects of many climatic and non-climatic factors [10].

![Figure 1. Dual Regulation System and Ecohydrology Components [10, 11].](image)

The fifth of the six themes that structure IHPVIII (2014-2021) is “Ecohydrology, Engineering Harmony for a Sustainable World”, permitting regional ecohydrological solutions to reduce the impact of global changes on hydrological and nutrient cycles and to address the increasing vulnerability of aquatic resources [12]. Five different focal areas under this theme are: hydrological dimension of a catchment – identification of potential threats and opportunities for sustainable development; shaping of the catchment ecological structure for ecosystem potential enhancement – biological productivity and biodiversity; ecohydrology system solution and ecological engineering for the enhancement of water and ecosystem resilience and ecosystem services; urban Ecohydrology – storm water purification and retention in the city landscape, potential for improvement of health and quality of life; ecohydrological regulation for sustaining and restoring continental to coastal connectivity and ecosystem functioning [12].

The Asia Pacific Centre for Ecohydrology (APCE) is a Category II Centre under the auspices UNESCO, hosted by the Government of the Republic of Indonesia through the Indonesian Institute of Sciences (LIPI) since March 28, 2011. This Centre has duties and functions in the effort to identify issues of water resources problems in the region Asia and The Pacific as well as potential solutions through the concept of ecohydrology. In order to achieve the targets, the Centre has determined four
strategic goals by: promoting local resources based ecohydrological research; strengthening local capacity to adopt ecohydrological concept and approach; providing easy access to local resources based ecohydrological information and knowledge; enhancing public awareness of local resources based ecohydrological practices [13].

3. Demonstration Site as a Tool for Ecohydrology Concept Implementation

There is an urgent need to stop decline in biodiversity and reverse the degradation of water resources due to increasing demographic growth, human migration and climate instability. The understanding of relationships between hydrological and biological processes at different scales is an important base to improve water security, enhance biodiversity and further opportunities for sustainable development by reducing ecological threats and maximizing harmony within catchment processes. The aims of the ecohydrology program are advancing the integration of social, ecological and hydrological research, and generating outcomes that enable the development of effective policies and practices for Integrated Water Resources Management (IWRM). Improving and sharing knowledge of different types of water-related ecosystems and the use and integration of innovative ecohydrological technologies are the main objectives of this program [14].

Most of the global landscape has been converted into agricultural land with spots of highly modified urban areas. A reduction of biomass and organic matter due to over-engineering of urban and agricultural landscapes lead to modify the water cycle from the intermediate disturbance level, to a model more stochastic and unfavorable for biota and human. These processes are impacting the material cycle by reducing carbon storage and nutrients transfer from mineral to organic forms. A two-steps strategy has to be elaborated and implemented to reverse those negative processes: reduction of energy and matter use per GDP and regulation of hydrological and nutrients cycles in novel ecosystems in order to enhance the global ecosystem carrying capacity [15].

UNESCO-IHP promotes the establishment of various demonstration sites around the world to apply ecohydrology solutions in watersheds at all scales since 2011. The framework serves to increase the ecological potential of a river basin and to mitigate intermediate forms of impact which helps to achieve sustainability of river basins by harmonizing the enhanced ecosystem potential with society needs [16]. A demonstration site plays a role as a tool for ecohydrology application dealing with issues of nutrient concentrations, water purification, aquatic habitats like wetlands, marshes, mangroves, cyanobacterial bloom, etc. This term of WBRSR (W-water, B-biodiversity, S-ecosystem services, and R-resilience), covering the four elements that should be taken into account in order to reinforce the sustainability potential. The establishment of new ecohydrology demonstration site must fulfill three objectives: identify knowledge gaps to address ecohydrological issues related to critical water ecosystems; showcase how better knowledge can contribute to more cost-effective and environmentally-friendly water management; and demonstrate system solutions and technology transfer in order to harmonize the ecosystem potential with societal need [17].

4. Ecohydrology Demonstration Site as Best Practice to Manage Water Resources

The restoration and creation of wetlands, including mudflats, mangroves and saltmarshes can be done using ecohydrology concept due to their ability to trap pollutants and sediment, to provide habitats for demersal and pelagic species and to convert excess water-born nutrients into plant biomass. Ecohydrology relies on low-cost technology to mitigate the impact of human activity on coastal zones throughout river basins, using the natural capacity of the water bodies to absorb, or process with no resulting estuary degradation, the nutrients and pollutants. Changing present practices is needed from official institutions based on municipalities or counties as administrative units. Rivers, lakes, estuaries and coastal waters will continue to degrade, no matter the integrated water management plans that are implemented without change in thinking and management practices [18].

Based on UNESCO web-platform, the ecohydrology demonstration sites in each location or country contains information and their main characteristics including: location, lithology/geochemistry, main description, ecosystem services category, applied ecohydrology

4
4.1. Pilica River Catchment Ecohydrology Demonosite in Poland

Pilica river catchment ecohydrology demonosite, is located in the Central of Poland comprising of a catchment-river-reservoir system including the Pilica River, and Sulejów Reservoir, a lowland reservoir (Figure 2). The Sulejów Reservoir is an artificial reservoir built in 1974 and was used as a drinking water reservoir for the Łódź agglomeration until 2004. It has currently function to mitigate flood and drought. The Pilica River is the longest left-side tributary of the largest Polish river with the catchment area of 9258 km$^2$ and total length 342 km. The average discharge is 21.2 m$^3$ s$^{-1}$ recorded at the Sulejow town gauging station. The riverbed in the middle section, has 20 to 60 m of width and the floodplain width ranges from 100–1000 m. The floodplain banks and slopes of the river are principally forested and covered by shrubs indicating mostly natural character. The GPS coordinates are about 51.850000 latitude and 19.900000 longitudes. Lithology/geochemistry conditions are fluvial sands of alluvial terraces and fluvial sands and fluvial gravel [20].

The mains problems encountered in the Sokolowka river and Sulejów Reservoir are eutrophication and toxic cyanobacterial blooms due to heavy pollution (P and N) from point and non-point sources of pollution. Agricultural sectors use of over 60% of the catchment results in increased supply of humic substances, nutrients and other pollutants. Sewage treatment plants contribute also periodically in exceeding chemical and biological standards. The concentrations of total phosphorous in the river may reach 700 μg dm$^{-3}$ [20].

Figure 2. Pilica River Ecohydrology Demosite [20].
Pilica river and Sulejów reservoir rehabilitation efforts were carried out by implementing the ecohydrology concept through monitoring of threats, assessment of cause-effect relationships, elaboration of ecohydrological tools and methods, and development and implementation of systemic solutions such as phytotechnology. This rehabilitation project took part in the LTSER Platform of the European Long-Term Ecosystem Research Network (LTER-Eu). Table 1 shows the total phosphorus load accumulated in the floodplain biomass in three different seasons: 123 kg in spring, 171 kg in summer, and 90 kg in autumn. The levels of P uptake by different biomass are as follow: the meadow community 74% (91.5 kg), 18% by *C. gracilis* and *C. vesicariae*, and 7% by *P. australis*. The content of phosphorus in plant tissues decreased from spring, in the range of 2.84 - 4.07 gPkg$^{-1}$ d.w., to the end of the growing season [Figure 3]. The potential accumulation of phosphorus was estimated as 255 kg P year$^{-1}$ for summer by floodplain vegetation. It is still possible to increase phosphorus retention up to 332 or 399 kg P year$^{-1}$ however, by implementing a conversion of 24% or 48% of the area [21]. Hydrological drivers, depending on the seasons, seemed to be primary importance in controlling the nutrient dynamics in a river. [22] reported that concentrations of phosphorus (P) and suspended matter (SM) and hydrological parameters were more closely correlated in the winter during low flows than in the summer during high flows. Based on the study of 3 catchments in Ireland, [23] reported the transportation of 80% of the P to rivers during the winter season and the largest losses during high precipitation periods.

**Table 1.** Seasonal variability of P accumulation by vegetation in the Pilica River floodplain [21].

| Communities | Contribution to floodplain biomass P accumulation [%] |
|-------------|------------------------------------------------------|
|             | Spring | Summer | Autumn |
| Meadows community | 74 | 49 | 70 |
| *Caricetum gracilis* and *Caricetum vesicariae* | 38 | 20 | 23 |
| *Phragmitetum australis* | 7 | 27 | 6 |
| *Scirpulum sylvatici* | 1 | 4 | 1 |

**Figure 3.** Phosphorus accumulation for predominant species in the Pilica River floodplain calculated per unit area [ha].
Ecohydrology implementation in Pilica river demosite showed good results in term of ecosystem quality improvement. Local and regional authorities considered seriously this concept as possible way to overcome ecological problems influencing economy sectors. However, the propose solution based on ecohydrology approach should involve the structure and operation of socioeconomic systems covering planning processes, implementation and evaluation to ensure that the program runs properly.

4.2. Lácar Lake Ecohydrology Demosite in Argentina

Lácar Lake ecohydrology demosite is located and belongs to the Lácar Lake and Huahum River Basin in the Province of Neuquén, Argentina (Figure 4). The GPS coordinates are about -40.166667 latitude and -71.350000 longitudes. Lithology/geochemistry conditions are mainly mesosiliceous tertiary volcanic, metamorphic and plutonic rocks. Several streams and rivers drain from headwaters to the Lácar Lake. The outlet is conveyed as runoff by the Huahum/Valdivia River to the Pacific Ocean. The Pocahullo River crosses the City of San Martín de los Andes with 26,000 inhabitants and drains the East part of the basin, equivalent to 20% of whole surface. Most of the watershed is under the administration of these two parks National Lanín and Nahuel Huapi Parks visited by 700,000 tourists every year [24].

Several main problems need to be solved in this lake area are: deforestation and soil erosion, water pollution, intensive urban and road development, natural and anthropogenic hazards (landslides, fire, floods, sediment), overgrazing causing erosion, eutrophication due to the increase of nutrients P and N. Ecohydrology approach was introduced in order to overcome these challenges through: development of a Spatial Decision Support Model for the watershed based, modelling of the basin, riverine restoration, mitigation of natural hazards, and promoting policies ecohydrology based. The main objectives of this activity include evidence-based policy formulation, involvement of local authorities/stakeholders in implementing ecohydrology management strategies, on-site training for young scientists and decision-makers, and dissemination of information for water management. The project has achieved its sustainability after 22 years with significant improvement: Increase of security against natural hazard, enhancement of environmental services, and restoration of water quality and biodiversity.
Table 2 shows the results of Fourier significant periodicities of monthly mean or maximum water level time series. A minimum water height at the end of the austral summer and beginning of autumn was recorded for the case of Lacar lake, probably due to reduced rainfall. The observed modulation is closely related to the extensive lake surface area and a very large volume of stored water. The continuous Morlet wavelet spectra for the Lacar lake (figure 5) shows the presence of significant interannual and near-decadal periodic oscillations. The near-decadal signal is stronger since the beginning of the 1980s, while the first is persistent throughout the entire record period [25]. Indication as an ultra-oligotrophic to oligotrophic trophic status of Lacar lake was also reported [26]. The ecological features analysis showed a physical and chemical features variability, strongly influenced by seasonal precipitation with an effect of dilution and a sediment load increase during the spring. The nutrient load (P and N) increased clearly in the sectors with human activities like ski resorts, and residential areas [27].

This Lacar Lake demosite is now recognized as a demonstration project of regional scope in the research, design and implementation of innovative measures based on ecohydrology, soft engineering, and participatory approach [22]. Continuous efforts to manage this demosite in sustainable manner are needed in order to maintain and strengthen ecosystem services of Lacar lake including evidence-based policy making support, local community and authority participation, data and information system integration.

| No | Lake     | Number of months | Fourier significant periodicities (period in years) |
|----|----------|------------------|-----------------------------------------------|
|    |          |                  | Monthly mean water level (m) | Maximum Monthly water level (m) |
| 1  | Lacar    | 435              | 2.5                             | 10                             |
| 2  | Steffen  | 341              | 10.7                            | 15                             |
| 3  | Escondido| 340              | 7.1                             | 14                             |
| 4  | Puelo    | 533              | 12.7                            | 17.1                           |

Table 2. Monthly mean and maximum lake water level of several lakes in Argentina [25].

Figure 5. Real part of the continuous Morlet wavelet spectra for water levels in Lacar (a) and Puelo (b) lakes. Light colors in the wavelet spectra correspond to high power [25].
4.3. Saguling Ecohydrology Demosite in Indonesia

Saguling Ecohydrology Demosite is hosted by Asia Pacific Centre for Ecohydrology (APCE) – UNESCO Category II Centre in collaboration with Research Centre for Limnology – LIPI. This demosite was constructed and inaugurated in 2016 and located in one of the rivers entering the Saguling Reservoir (Figure 6) [28], the Cibitung River with river stream of 35.5 km². The GPS coordinates are about -6.988621140444099 latitude and 107.44601917266846 longitude. Lithology/geochemistry conditions are mainly quaternary volcanic rocks with miocene sedimentary facies (limestone), and granite, granodiorite, diorite, alluvium, pleistocene volcanic facies. The Cibitung River catchment is one of tributaries in the upper Citarum river basin with the Saguling Reservoir as the outlet point (Figure 7). This river has vital importance for West Java Province and Jakarta, in terms of economic development and the prosperity of the people. This demosite aims to provide examples of solving water resource problems with an ecohydrological approach and at the same time as a field station for research. The principal regulating services are waste-water treatment, biological control, erosion prevention and maintenance of soil fertility among others. Tourism as cultural service is also relevant [29].

**Figure 6.** Part of Saguling Ecohydrology Demonstration Site.

**Figure 7.** The whole catchment area of the ecohydrology demonstration site [28].
Water pollution control with phytotechnology applications was built to control domestic waste, sago processing and agriculture/rice fields. In addition, to control pollution, it is expected to improve the economic aspects of the community with fish ponds that feed from these water plants. Table 3 summarizes the field condition; improvement measures necessary to carry out as well as the standard norm. In addition, an online monitoring of the weather and the Cibitung River was integrated. It is expected that this ecohydrology demosite serves as a learning medium and can be applied elsewhere, so that in the long run it can improve the environmental quality of water resources. The initial stage of ecohydrological demosite development consists of three main aspects: monitoring the quality - quantity of river water and weather elements; ecohydrological simulation modeling; and control of domestic water pollution, agriculture & sago home industry.

Figure 8 shows that the concentration of nitrite and COD of sago were higher than the values of standards quality, 0.06, and 50 mg/L respectively, for fishery based on Government Regulation No. 82/2000. The presence of *Lemna* as floating plants can improve water quality by taking up nutrients in plant biomass reducing water conductivity and TDS (Figure 9) [28; 29]. The capabilities of two aquatic plants, *Lemna minor* [30] and *Ceratophyllum demersum*, in reducing pollutants were also reported by [31]. Their study showed that the concentration of heavy metal Pb decreased up to 81.1% in *C. demersum* and 75.5% in *L. minor*. Other aquatic plant, *Eichhornia crassipes*, was tested by [32] to absorb and accumulate Pb, Cd and a mixed solution. This plant has ability to remove Pb, mixed solution (Pb+Cd) and Cd with efficiencies of 88.10%, 86.06% and 85.83% respectively.

**Table 3. Demonstration site condition**

| Object          | Aspect        | Standard/Norms                                      | Improvement Measures                                      |
|-----------------|---------------|-----------------------------------------------------|------------------------------------------------------------|
| Clean water     | Quality       | Permenkes No. 492/2010 (drinking water)             | a. Quality improvement including parameters including screening, grit removal, sedimentation, chlorination, filtration, disinfection, and save storage |
|                 | Source        | PP No. 82/2001 (water pollution control)            | b. Plumbing renewal.                                      |
|                 | Plumbing      |                                                     |                                                            |
|                 | system        |                                                     |                                                            |
| Domestic        | Sewerage      | Kepmen-LH No. 112/2003 (domestic wastewater standard) | a. Development of domestic wastewater sewerage system.  |
| wastewater      | Quality       | Permen-LH No. 5/2014 (wastewater standard)          | b. Integrated sewerage infrastructure development by using phytoremediation pond. |
|                 | control       |                                                     |                                                            |
| Solid waste     | Disposal      | Undang-undang (UU) No. 82/2008 (solid waste management) | a. Temporary disposal system development by each household. |
|                 | system        |                                                     | b. Change of daily behaviour on solid waste treatment.   |
|                 | Separation    |                                                     | c. Household waste bins to be separated according to the solid waste category. |
|                 | at source     |                                                     |                                                            |

The results of the first phase of the development of ecohydrology demosite at the Cibitung river catchment showed the high potential application of ecohydrology and phytotechnology measures in the Saguling region, which has attracted the interest of local community and authority. However, it is important to note that this demo site should be revitalised and relocated to appropriate place in the future due to potential land use change by the local government and community.
5. Lesson Learnt and Challenges

Implementation of ecohydrology concept in three different demo sites indicated that this approach was viable to improve and manage water quality and its ecosystem in order to support ecosystem services. Excess of nutrients in the pollutants and sediments were trapped and converted into plant biomass, such as *Lemna minor*, *Ceratophyllum demersum*, and *Eichhornia crassipes*, in the case of Saguling demo site, while the P uptake levels in Pilica river vary depending on biomass: 74%, 18% by *C. gracilis* and *C. vesicariae*, and 7% by *P. australis* respectively. It permits to provide habitats for demersal and pelagic species by restoration and construction of ponds or wetlands in appropriate areas. Ecohydrology can also rely on low-cost technology to mitigate human activity or climate variability impact, as shown in Lacar lake, where physical and chemical features variability were strongly influenced by seasonal precipitation on river basins throughout coastal zones. The natural capacity of the water bodies has ability to absorb, or process the nutrients and pollutants without ecosystem degradation [18].

Ecosystem quality improvement in Pilica river demo site attracted local and regional authorities and considering seriously ecohydrology implementation as possible way to overcome ecological problems influencing economic sectors. Involvement of structure and operation of socioeconomic systems covering planning processes, implementation and evaluation is important to ensure the program runs properly. Meanwhile, continuous efforts are needed to manage Lacar lake demo site in order to maintain and strengthen its ecosystem services. These include data and information system integration, local community and authority participation and evidence-based policy making support. High potential application of ecohydrology was also recorded in Saguling demosite at the Cibitung.
river catchment. For the reason of land use change by the local government and community, this demo site should be revitalized and relocated to an appropriate place in the future.

Water as the major driver for biogeochemical evolution, biological productivity and biodiversity are the fundamental assumption of Ecohydrology. Understanding of both productivity and underlying water-biota interactions of water resources is needed. Ecohydrology aims to do harmonization between enhanced ecosystem potential and societal needs by ecosystems carrying capacity improvement. In this context, it refers to regulate different processes in order to increase their ecological potential in the novel ecosystems including: ecosystem services, biodiversity, water resources and resilience to anthropogenic stress and global change [10]. Although ecohydrology complies with Integrated Water Resources Management (IWRM) concept giving novel potential tools to support SDGs achievement, it needs more field data and information from different areas and best practices in order to get comprehensive solution for sustainable water resources management in the future.

6. Conclusions
Within the framework of achieving SDGs targets, UNESCO IHP has been promoting trans-disciplinary approaches for land and water management for better environmental, social and economic outcomes. Under this program, the ecohydrology approach involves the development of tools that integrate basin-wide human activities with hydrological cycles in order to sustain, improve and restore ecological functions and services in river basins and coastal zones as a basis to support positive socioeconomic development.

Based on the implementation of ecohydrology concept in three different demonstration sites, the results showed that it has been agreed as the solution to improve and restore river basin and lake ecosystem functions and services. The development of tools integrating basin-wide human activities with hydrological cycles should be involved. As ecohydrology is a nature-based solution, it is possible to restore the carrying capacity of a degraded ecosystem to a certain level by understanding the functioning of the ecosystems. However, it is important to note that the implementation of ecohydrology concept should consider economic valuation, political and government support as well as local society involvement in order to get effective and sustainable solutions for managing water resources.

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