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Review

Climate Change Critique on Dams and Anthropogenic Impact to Mediterranean Mountains for Freshwater Ecosystem - a Review

Shan-e-hyder Soomro[1, 2, 3#], Jiali Guo[1, 2*#], Xiaotao Shi[1, 2#], Senfan Ke[2], Yinghai Li[2], Caihong Hu[3], Haider M. Zwain[4], Jiahui Gu[2], Zhu Chunyun[2], Ao Li[2], Liu Shenghong[2]**

[1]Hubei Key Laboratory of Intelligent Yangtze and Hydroelectric Science, China Yangtze Power Co., Ltd., Yichang Hubei, 443002
[2]College of Hydraulic and Environmental Engineering, China Three Gorges University, Yichang 443002, China
[3]College of Water Conservancy Science & Engineering, Zhengzhou University, Zhengzhou 450001, China
[4]College of Engineering, Al-Qasim Green University, Al-Qasim Province 51001, Babylon, Iraq

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Abstract

The average annual temperature, precipitation, and evaporation patterns are some of the characteristics which indicate to a globe where climate is rapidly changing. It remains uncertain regarding how this rapid climate change will impact freshwater biota; however the consequences could be absolutely catastrophic. It is urgently needed to better adapt and maintain the fragile system that comprises the Mediterranean ecosystems. Water shortages and changes in the land use can impact water quality and the watershed's ecosystem. Changes in temperature and precipitation trends can increase the intensity of land use, the increase of water depletion, and the degradation of water quality. The effects of climate change on eco hydrology change runoff, evaporation, surface storage, and soil moisture, that all have immediate effects on the biota and biodiversity of region. It is supported by studies on eco hydrological impacts on local watersheds. The spatial pattern and surface water dynamics of watershed systems are utilized as a perspective using which to examine the hydrologic consequences. The impacts of climate change on rainfall, evaporation, soil humidity, lakes level, and quality of water, habitats, species migration, biodiversity, and economies have been investigated. The potential climatic impacts on watershed ecosystems are determined by a spatiotemporal assessment of variations in temperature and precipitation projections from a multimodal ensemble. The susceptibility of a watershed changed depending over its geographic region, terrain, and human influence. As such a manner of dealing with climate change, improving watershed systems could be beneficial. Various techniques have

#The authors contributed equally to this paper.
*email: fishlab@163.com
**email: jiali.guo@ctgu.edu.cn

been proposed which can protect watersheds against by the consequences of climate and land use change. Strengthening ecosystem vulnerability requires knowledge of the Eco hydrological processes. This review anticipated effects of climate change on the Eco hydrology of watershed systems in the Mediterranean and implies strategies for adaptation to create the mechanisms more responsive.

Keywords: sustainable aquatic ecosystem, dams, environmental effect, anthropogenic disturbance, mediterranean mountains, and climate change

Highlights

- Water shortages and changes in land use can impact water quality and the watershed's ecosystem
- The effects of climate change on Eco hydrology change runoff, evaporation, surface storage, and soil moisture, all have immediate effects on the biota and biodiversity of region.
- The Mediterranean is especially vulnerable to the invasions of non-native species due to the frequency with which natural disturbances like floods and droughts.

Introduction

The long-term effectiveness of Mediterranean water resources and ecosystems is under risk due to climate change's possible impact on hydrological processes [1]. The Mediterranean region could be drastically influenced by climate change, according to expert opinions [2-4], particularly if there is a significant shortage of water, such as semiarid and arid regions. Throughout the scenario of a 2ºC rise in temperature, grasslands and arid may prevail at the expense of coniferous forests [5]. It has a potential to impact regional hydrology and water resources for wetlands. Unfortunately, there is a significant amount of uncertainty about the specific outcomes. Increases in temperature were forecasted to be highest over Ukraine and Eastern Turkey, while being less serious over the Mediterranean [6, 7]. Due to region's high demand and low supply of freshwater, water management is a pressing economic, political, and social issue in the Mediterranean [8]. A large number of lakes in the Mediterranean region are all in danger of running dry because of neglect and overexploitation, that in ultimately decreases water levels and makes the lakes highly vulnerable to climate change. The Mediterranean region is becoming more at risk of water shortages if the current trend continues [9]. Whenever it regards climate change, the Mediterranean basins distinguish out among the most conspicuous and vulnerable around the globe. Warm and dry conditions, such as a rise in temperature extremes, a reduction in rainfall events, and a change in rainfall, were consistently predicted by several climatic models [10, 11]. Several Mediterranean countries have increasingly developed a collaborative effort to protect forest ecosystems in response to the awareness that impacts on biodiversity and forest ecosystems in the watersheds are crucial to long-term sustainability [12]. Protecting the Mediterranean region's rivers from the increased susceptibility and projected Eco hydrologic impacts needs immediate effort. Although there is scientific evidence of extensive hydrological and ecological implications from climate change [13]. Our review enhances the awareness of these effects by studying it in the context of Eco hydrologic processes that operate in watershed systems at the regional scale. The research of the hydrologic mechanisms influencing ecological pattern and process is termed as Eco hydrology [14]. There are significant unknown factors regarding regional consequences, despite the fact that global temperatures are expected to rise more in the next decade than at any point in the past years. Within the next decade, the Mediterranean region is expected to experience significant warmth [15, 16]. [17] a 2ºC temperature rise is projected for the Mediterranean Basins from 2031 and 2060, that will result in a reduction in rainfall distribution over the Mediterranean, higher dry spells, extra extreme heat waves, and prolonged droughts that may result in consequence for agriculture, tourist, hydropower, and wildfires. Extremely vulnerable watershed systems in the Mediterranean will certainly feel the effects of climate change directly. Variations in the weather patterns have been observed in the Mediterranean world. Mostly in Northern Hemisphere, continental rainfall increased by 20th century, but still it started falling in other regions of the world [18]. In certain areas of the Mediterranean region, less rain and more evaporation are affecting water levels in lakes and groundwater to decline. While at the same time, more contamination is affecting ecosystems and the health, lives, and process of managing a livelihood of inhabitants that lack access to clean drinking water and basic sanitation [19]. Climate change might make it extremely difficult for the Mediterranean region to achieve long-term sustainability. In addition, climate change could make land degradation, droughts, and agricultural production worse, and also raises major risks to human health, ecosystems, and countries' economic systems. It is therefore extremely crucial and essential to protect these sensitive watersheds from the effects of climate change, therefore this review addresses this need by reviewing potential impacts of climatic change on the Eco hydrology of Mediterranean watershed systems.

Hydrologic Characteristics

The hydrological characteristics of Mediterranean ecosystem basins are influenced by the common environment that distinguishes it. Periodic rainfall trends cause severe floods in the autumn and winter, caused by such a severe drought period resulting in minimal or nonexistent river flow [20] because variable nature of winter weather is unpredictable [21]. Runoff coupled with fall or winter rainfall and spring snow melt contribute to the rivers of central Chile and sections of the Mediterranean Basin, wherein hydrographs exhibit a heterogeneous distribution [22]. Human-caused variations to instinctual Mediterranean terrains (med-landscapes) such as clearing of native vegetation, soil disturbance, the construction of impermeable surfaces, and the cultivation of accessible farming practices cause more rapid runoff and river flooding during storms and reduced groundwater recharge, leading to lower dry season flows [23, 24]**.** Because of the large number of impervious surfaces in urban environments, even mild rainfall events can result in localized stream flooding and increased outflow [25]. [26] Increases in impermeable surfaces in urbanized sites in southern California was observed to increase runoff coefficient and caused discharge peaks to decrease. If there are number of wells in a region, fluctuations in runoff and groundwater extraction can depletion aquifers, resulting in a detrimental effect on stream flows throughout seasonal or long-term droughts [27]. While anthropogenic changes to med-catchments tend to exacerbate the regular seasonal variation in discharge, such influences can be mitigated by other anthropogenic activities but less information is available for natural lakes and watersheds [28, 29]. River flows can be increased by groundwater recharge flows or sewerage system plant flows during the dry season, maintaining certain rivers flowing that would otherwise dry up [30]. Variations of vegetation and evapotranspiration levels are often linked to human-caused adjustments in hydrological processes in med-catchments. Exotic tree plantings can increase evapotranspiration and minimize discharge by removing native vegetation [31], but the opposite happens if deteriorated shrublands, crop fields, or grassland substitute forest area and shrublands [32]. Lower flows and longer dry periods for unmanaged rivers have come from the abandoning of highland agricultural regions in southern Europe, which has allowed natural vegetation to flourish [33]. Rivers have been extensively transformed, as they are mostly in dry and semi-arid regions, to assure proper water supply in times of crisis. In the Mediterranean and many other regions, agriculture activities make up the vast majority of water usage. Dam activities have had the greatest influence on river flows due to manner the change the regularity and intensity of such flows [34, 35]. Several dams in the Mediterranean Basin are built in Spain and Turkey; such projects have a massive effect on stream flow dynamics in downstream, reducing flooding, extending low-flow periods, and changing flow periodicity [36]. Due to the diversion of water from two major reservoirs situated on the headwaters of the Tagus River in Spain, its river flow is abnormally low underneath the dams, and even less throughout natural droughts [37]. The shift from dry-land to irrigated agriculture in certain parts of Spain has increased the region's need for water. Researchers used spectral approaches to represent natural hydrological processes for med-rivers and evaluate its responsiveness to land use changes and dam development [38-40] daily average discharge values for major rivers Warren River, Doring River, Salinas River, and Ebro River [41-44]. Nevertheless researchers can check out the influence of climate change on hydrographic changes. Low-flow irregularities are becoming more frequent and are longer lasting, and its timing has changed.

Human Impacts on Vegetation and Soils

Changes in vegetation and soils in Mediterranean environments have significant consequences for sediment erosion, transport, and deposition, that all have profound implications for the geomorphology of streams. Later throughout the winter, when water tables have raised; Mediterranean forests because mild floods with minimal sediment loads [45]. In addition, runoff from cleared land increases flood frequency and intensity, along with suspended sediment and bed loads [46, 47]. Excess sediment inflows to streams can affect rivers, decreasing its depth and diminishing the distinction between lakes and riverbanks. Typically, as a catchment increases, more sand and finer sedimentary layer is exhibited on stream banks, that have consequences for solid substrates involvement [48, 49] Whenever man-made reservoirs become blocked with sediment, then amount of sediment carried downstream is decreased [50]. Catchment flow, flood frequency and intensity, erosion, and sediment deposition may all be increased by wildfire in Mediterranean settings; however, these effects rapidly reduce as the land vegetation [51]. Runoff and erosion can be affected by disaster response strategies including fire prevention and fuels removal via mechanical action or forest fires [52]. It is possible for flash floods in populated med-catchments to erode stream beds, erode stream channels, and carry large quantities of suspended particles [53, 54]. Reducing the sedimentary layer, bed, and habitat variability by straightening river channels and covering them with riprap, concrete, or other impermeable materials accelerates the transit of flood waters [55]. Stream beds may be excavated by flood flows in natural rivers with impermeable catchments, leading to incision and fallen banks, and sediment inputs could be inadequate [56]. Rivers and streams are blocked off from their riparian pathways and floodplains because of the common practice of lining channels with embankments or designing channels with excess capacity to prevent

flooding of adjacent areas, which improve the capacity in historical floodplain regions.

Land Use Changes Affect Temperature

Changing the hydrological cycle, particularly; the riparian vegetation can impact stream temperatures and light levels in Mediterranean environments [57, 58]. Changes to land use typically increase overland flow during floods while decreasing groundwater flow interaction and groundwater inflows to rivers, resulting in higher stream temperatures [59, 60]. Evaluating the impacts of habitat loss and fragmentation is essential for biodiversity conservation [61]. Land use changes often cause dry season flows to decrease, leading to riverbeds whose temperatures are identical to the surrounding atmosphere. The thermal regimes are influenced by dams, which often lead to thermally stratified reservoirs upstream and seasonal increases or decreases in downstream temperatures depending on whether reservoir discharges. Where riparian vegetation has been diminished or removed, stream temperatures and light levels tend to rise [62]. Some riparian areas have been protected or restored, exotic plants have been planted along streams, or water supplies to relatively intact riparian zones have been boosted by return flows, and yet in other areas of the Mediterranean, a loss of riparian vegetation has not been recorded. The riparian canopy coverages along natural and degraded streams in southern California were found to be very similar during fieldwork, but [63, 64] vegetation covers significantly less in urban streams than natural or agricultural streams. [65] Natural rivers exhibited greater bank protection than concrete-lined channels and natural streams were warmer than channelized streams that were obtaining urban runoff or wastewater. The consequences of increased suspended sediment transport from landscape or channel erosion can counteract the beneficial effects of reduced riparian vegetation in ambient lighting.

Water Quality for Sustainable Aquatic Ecosystem

Climate change may exacerbate the decrease in water quality [66]. While rising sea levels would enhance saltwater intrusion into aquifers and estuaries in coastal locations, higher temperatures and evaporation increase the salinity of lakes and reservoirs [67]. In terms of biotic content and chemical composition, the quality of surface water and groundwater differs across the Mediterranean and frequently changes over time [68] The quality is often adequate in the northern regions for the majority of uses particularly for drinking water consumption and maintaining aquatic ecosystems. Watersheds in the South experience a change in their water quality as a consequence of increased treatment costs for drinking water [69]. It illustrates the difference between the north and the south in terms of the resources that are available and their quality. In a study conducted in Portugal, it was discovered that modest rainfall changes brought on by climatic change caused soil erosion in wheat fields to increase [70]. They indicate that humid watersheds can become semi-arid due to climate change [71]**.** Hardness groundwater in carbonate rich places and turbidity are two problems that affect water quality in both the north and the south. In southern watersheds, salinity presents a threat to freshwater resources, and water quality often deteriorates further downstream. Efficiency of this is anticipated as a result of a changing climate. It's estimated that there are hundreds of thousands of landfills and dumps of varying sizes spread over the Mediterranean. The contamination of both surface and groundwater sources may increase as a result of increased flooding caused by climatic changes [72]. Desertification in the Mediterranean is largely attributable to soil erosion, which reduces the soil's ability to support plants in borderline climates. Erosion rates may go up or down as a result of global climate change-induced drier conditions, depending on the relationship between precipitation and environmental conditions [73].

Environmental Issues of Dams

Water scarcity affects a wide range of industries, including those dealing with regulation, storage, provisioning, transmission, factor productivity, strategic planning, and conservation management [74, 75] The advantage of the water potential to meet the needs and objectives such as drinking, agriculture, industry, generating non-polluting hydropower energy, flood control, and improved water quality and quantity is considered to be constructed large and small dams and small irrigation networks of rivers in different countries. Dams not only store water for usage throughout the year, but they also serve a variety of recreational and tourism functions [76, 77] Despite the many positives associated with dams, especially large dams, their construction can have both immediate and long-term negative effects on the local ecology [78]. Studies have been conducted by various international organizations to prohibit water supply projects in poor countries [79, 80]. As a result, it's becoming increasingly crucial to take cultural, social, and economic growth into account while planning for the future of water resources and their associated ecosystems. The massive environmental changes brought on by the building of dams and power plants will ultimately result in the destruction of numerous environmental structures, the relocation of species, and the loss of vast swaths of flora [81]. Identifying and methodically evaluating the consequences of projects, programs, and plans on the physical, chemical, social, economic, biological, cultural, and environmental

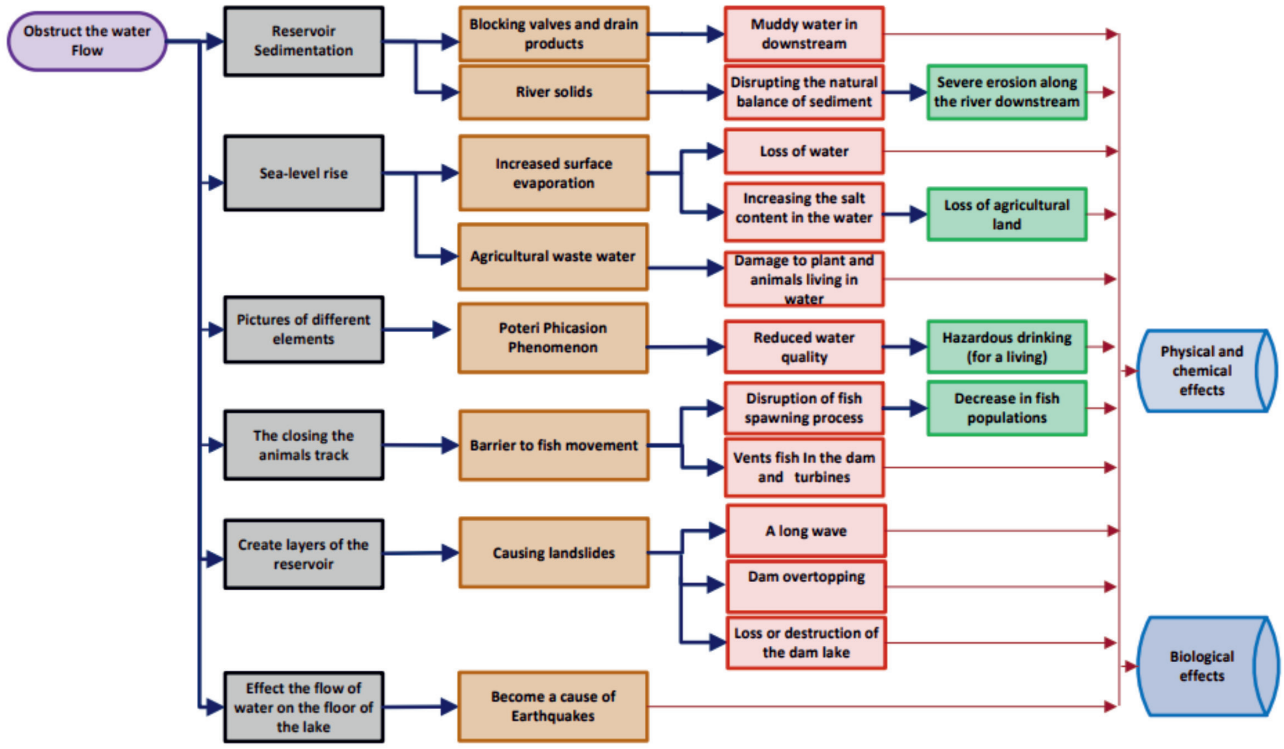

Fig. 1. Physical, chemical and biological effects of dams.

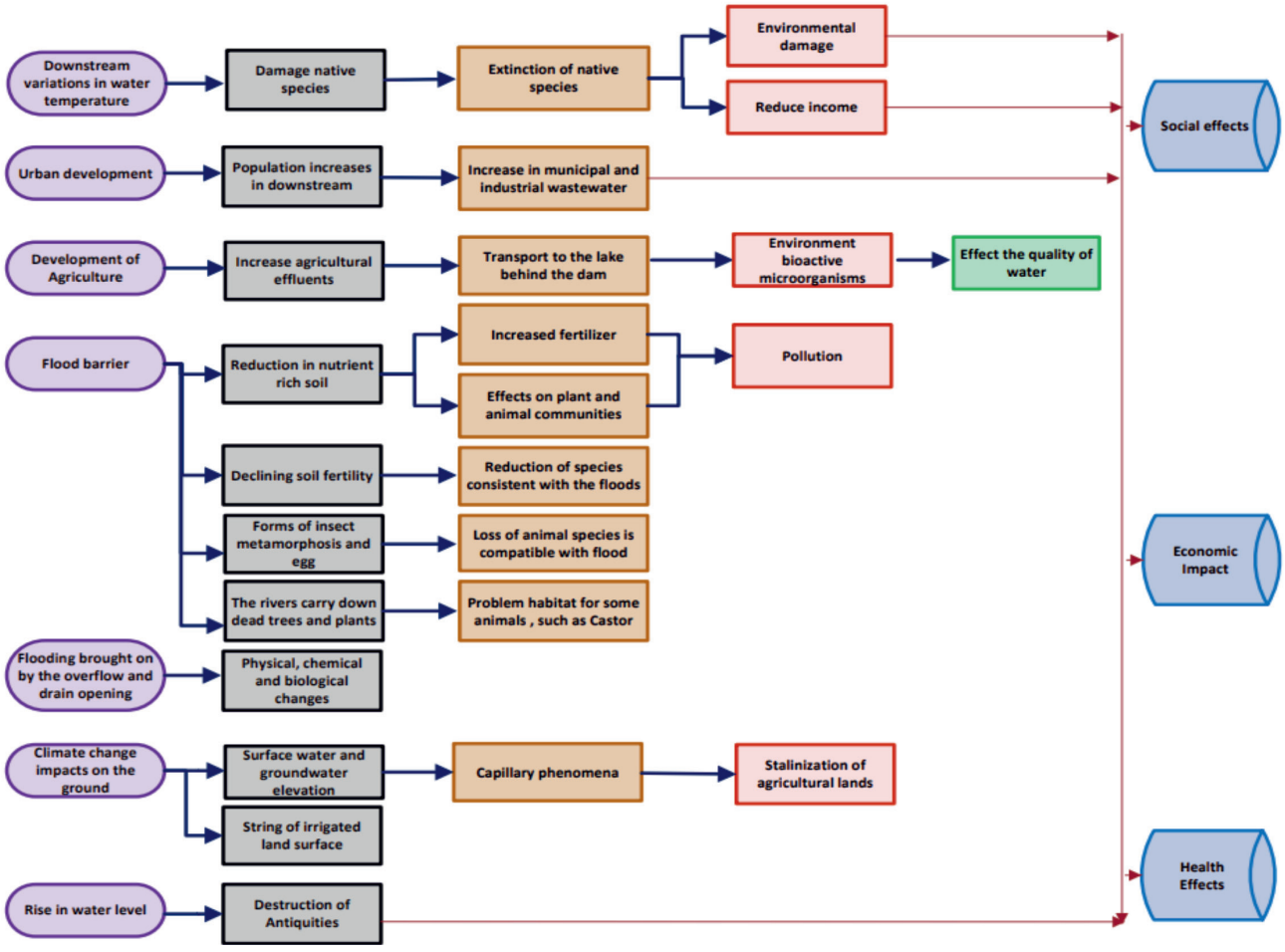

Fig. 2. Social, economic and health effects of dam construction.

components shown in figures 1 and 2 is one strategy for mitigating their negative effects on the environment. Studies of this nature help bring the practice of water resource development projects in line with sustainable development goals, and ultimately lead to the most efficient use of a country's water resources with the fewest negative effects on the environment, a key goal of IWRM. The optimal number of short dams in the watershed are predicted to be achieved by taking into account a variety of parameters for selecting a dam site and developing a gravity relationship between them [82]. If reduction the heights of dams and/or replace large dams with small ones, the drop in benefit of implementing projects for a large region would be less than the losses and costs we may face due to reservoir damage or natural resources losses [83]. In addition to storing water for agricultural uses and preventing seasonal and potential floods, small dams are also used for aquaculture, tourism, and creating new jobs. The downstream agricultural areas are another focus of this project's development and upgrading efforts.

Anthropogenic Disturbance

Rivers in Mediterranean region has experience a wide variety of disturbances, both naturally occurring and caused by people. Seasonal floods and droughts are regarded to be natural calamities, however frequently, human activity like water inputs and diversions have made them worse [85]. Species appear to have developed protective mechanisms against it or recovery mechanisms from these natural disturbances [86]. Furthermore, exception of greater stability, there is no evident fire-adaptive mechanisms in river in-stream and riparian ecosystems compared to terrestrial vegetation in Mediterranean climates [87]. In terms of the selective pressure on drying qualities, it is likely that the evolutionary effects of drought disturbance have been considerably more significant than those characteristics obtained by wildfire. There are many anthropogenic disturbances in Mediterranean rivers. Human activities have had an impact on med-regions around the world for centuries, because of the various periods of human settlement and settlement densities, the nature and extent of human effect varies among the Mediterranean regions of the world [88]. Moreover, the first water diversions for agriculture and human consumption along with the introduction of non-native fish started [89]. Since then, the Med-Basin has experienced significant landscape changes and the resulting impacts on river ecosystems. After the entrance and settlement of Europeans between the fifteenth and eighteenth centuries, the other med-regions experienced human influences afterwards, and they increased dramatically [90]. Similar disturbances carried on by farming and raising cattle, using industrial methods, increasing the number of people, and other related activities affect all med-regions. Fluvial geomorphology, temperature, and the amount of sunlight have all changed as a result of changes in land use brought on by human activity in the Mediterranean Rivers [91]. Additionally, nutrient loads, pollution, salinity, and organic matter dynamics have almost all raised [92]. In addition to increasing habitat destruction, changes in land use have also increased human population expansion, which has encouraged biological invasions and human-caused forest fire [93]. The richness and composition of aquatic biota have been and are being profoundly altered as a result of human activity, which has also contributed to a general homogenization of aquatic fauna and increased the likelihood of extinction for many species. Lower water levels and increased nutrient availability can lead to an increase in riparian plant biomass. Climate change impacts water temperature, flow regime, channel morphology, and sedimentation, which can be major factors in influencing invertebrates and fish in rivers [94]. Extreme weather, such as floods, heat waves, and wildfires, are expected to become more common in the future as a result of climate change in med-regions. All Mediterranean regions will experience warming that is more severe than the world average, less precipitation each year, and higher average temperatures. More frequent flash floods are predicted for the Mediterranean, but annual runoff is predicted to decrease [95]. Due to the high potential evapotranspiration of vegetation in med-regions, the decrease in river discharge is more likely to be connected to temperature rises than to declines in precipitation [96]. Because of anticipated changes in land use and increases in water demand, the current crisis is expected to worsen, resulting in even lower river discharge [97]. Species will have to make a choice between adapting to new conditions and migrating to new habitats, while species in med-rivers may be able to adapt to climate change up to a certain threshold due to their unique life-history characteristics [98]. Changes in the diversity and abundance of river species, as well as alterations in the course of their lives and probably even local and regional extinctions, are all in the Mediterranean [99]. Different sorts of disturbances, unrelated to humans, are emerging in the med-regions and elsewhere around the globe. These pollutants have been reported to have broad and potentially deadly or sub lethal impacts on species. Freshwater fish in med-rivers showed hormonal disturbance and intersexuality because of hormones found in water and soil samples, that indirect effects of these pollutants on ecosystem functions are equally significant [100]. There are additional secondary consequences on ecosystem services from such toxins. Decomposition rates of leaf litter are enhanced by nutrients in Mediterranean rivers of because their increase microbial activity [101] and some organic contaminants have been demonstrated to have the opposite impact [102]. A seasonal change in hydrologic processes makes Mediterranean rivers particularly susceptible to contamination and water extraction in the dry season

[103]. There is a greater decline of aquatic wildlife in Mediterranean regions than in any other global region [104]. In addition, while compared streams throughout Europe, Mediterranean rivers have a miserable ecological status [105]. In addition, the Mediterranean is especially vulnerable to invasions of non-native species due to the frequency with which natural disturbances like floods and droughts offer suitable conditions for these invaders to establish new populations in the region [106]. Due to this, there is a significant increase in the taxonomic and functional similarities amongst med-regions as a result of species migrations. In fact, the number of non-native fish species in all Mediterranean regions than there is native fish species [107]. Organisms in Mediterranean rivers may be able to use refuges the same manner organisms use them to escape environmental stresses [108]. It's important to keep in mind that not all disruptions are considered equal, and many of them might endure significantly longer than the lifespan of species. A river may have fewer refuges to help people escape the effects of salinization than they have refuges to help people deal with hydrological disruptions. This is due to the fact that hydrological disturbances can occur on a regional scale, but salinization only affects the local level [109]. Species' ability to recover from human disturbances is contingent on their tolerance of that disturbance, their ability to seek refuge during the disturbance, and the proximity of nearby undisturbed habitats [110].

Future Strategies

Numerous studies have demonstrated that river discharge is generally decreasing across nearly the entire Mediterranean basin. The long-term trends in precipitation and the presence of significant and positive temperature trends during the last six decades have been substantiated. The response of rivers is comparable with the climatic evolution, although most studies have found climate change cannot adequately prepare for the scale of observed hydrological changes. Importantly, these land cover changes have occurred primarily in the mountain headwaters, the source of the vast majority of the water for the Mediterranean basins. Variations in climate and plant life at different places mean that estimates of the impact of vegetation on runoff generation are inaccurate [111]. Nevertheless, it has been repeatedly shown that deforestation raises the average yearly outflow, that can be explained by variations in evapotranspiration and infiltration rates [112, 113] Although it depends on the type of change and the final landscape structure, the majority of researchers have identified the significant significance of land cover change at the regional level [114]. Variations in the annual amount of water are only one factor that has changed; the seasonality of river flows has been observed to change. Decreased springtime peak flows and soil moisture depletion, resulting to more noticeable summer low flows, are mostly attributable to a generalized drop in snow accumulation throughout winter and earlier melting. Changing snow cover may have an even greater impact on hydrology in locations with growing vegetation density, when evapotranspiration demands are highest in spring and summer. Future projections show current tendencies in environmental variables will accelerate significantly. Thus a scenario would have a devastating effect on the snowpack, especially at lower and intermediate elevations. Proportionally was expected to increase in most headwater locations, paralleling patterns seen in the majority of the European part of the basin and adding to the effects of climate change. As a result of the predicted progressive abandoning of the most marginal croplands and grazing regions, the current trend in North Africa, the Middle East, and parts of Turkey may change. Therefore, the current and future development of natural vegetation will strengthen the consequences of expected climatic changes, leading to a general decline in the availability of water resources across most of the Mediterranean mountain areas. Hydraulic infrastructure such as reservoirs, canals, groundwater pumping, and treatment plants have played essential roles in meeting rising water demand despite falling water availability due to environmental change. In order to store large volumes of water or, in certain circumstances, transfer the water long distances, in between basins, these methods are costly, complex, and long-term. This ensured the power generation in hydroelectric and nuclear facilities, allowed for the development of large-scale irrigation areas, and enhanced the quality of drinking water. Increased food and energy output, guaranteed water quality and quantity for urban areas, and less severe and less frequent flooding in moderate areas are only some of the concrete progress of water resource management [115]. The Mediterranean region has reached a point where water strategy based on the construction of major reservoirs and canals is no longer sustainable or desirable. There are few suitable locations for additional dams to be built, at least in the more industrialized countries of the basin, and there is growing community opposition to the building of new reservoirs in the Mediterranean mountain regions. Under oceanic climate conditions and in forested locations, where soil erosion is minimal, reservoirs could last for hundreds of years. However, in semiarid regions with a Mediterranean climate, soil erosion is a primary problem because large levels of suspended sediment and bedload transfer rapidly reduce reservoir capacity and lifespan. Only after a few decades of operation in the 20th century, certain reservoirs in the semi-arid Mediterranean become unsustainable [116]. These concerns illustrate the exchange to be made between financial expenses, social and environmental issues, reservoir lifespan, and societal advantages. It was expected, in the worldwide planning and administration of reservoirs, that annual water resources and the fluvial regime would remain

reasonably steady over time. The characteristics of the fluvial regime are distributed against water demand to determine the infilling regime for a reservoir [117, 118]. As a result of significant natural inter-annual variability, seasonality of water resources, and diminishing stream flows predicted for the future decades, it is not an exaggeration to state that Mediterranean countries are among the most affected by water stress globally. Many factors, including reservoir size, snow's role in the fluvial regime, precipitation and outflow trends within the basin, and reservoir utilization, must be accounted for while formulating a reservoir management plan.

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Author Contribution

Conceptualization: (Shan-e-hyder Soomro), (Jaili Guo) and (Xiaotao Shi); Methodology: (Shan-e-hyder Soomro), (Caihong Hu), (Jiali Guo), (Senfan Ke) and (Yinghai Li); Literature Search: (Jiahui Gu), (Zhu Chunyun), (Ao Li) Original Drafting: (Shan-e-hyder Soomro), (Jiali Guo); Critical Review: (Jiali Guo), (Xiaotao Shi) and (Haider M. Zwain); Editing: (Shan-e-hyder Soomro) Funding Arrangement: (Xiaotao Shi and Jiali Guo).

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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