

Influence of Dams on River Ecosystem and Its Countermeasures

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1. Introduction

Dam construction is an important engineering measure in dealing with the relationship between water and human being. In the traditional hydraulic engineering, a great deal of dams and dikes were built for the purpose of “harm exception and benefit enrichment” [1-2]. Meanwhile, large-scale river repair have also been done [3-5]. Dams have huge economic benefits and social benefits, such as preventing flood and reducing the disaster, adjusting the water quantity, irrigating and generating electricity [6-7]. However, in dam construction, some disadvantages may be caused to the river basin. With the development of the society, more and more scholars began to consider the effects of dam construction to the river ecosystem [8-10].

2. The Effects of Dam Construction to the River Ecosystem

Dam is an important engineering measure in dealing with the relationship between water and human being. Meanwhile, it is also a significant approach to maintain the balance of ecosystem. The damming of a river creates a reservoir upstream from the dam. The reservoir waters spill out into the surrounding environment, flooding the natural habitats that existed before the dam’s construction. Up to the present, over 400 000 km² of the earth have been flooded due to damming [11]. This argument remains to be proven scientifically by empirical data.

Dam construction affects the river ecosystem. The impacts of dams to the downstream can be generally categorized into physical changes and their biological consequences [12]. Physical changes involve river and floodplain hydrology, sediment movement and channel structure [13]. Biological consequences include virtually all aquatic and floodplain biota, either through direct physical influence or because of indirect effects on biological interactions and food-web processes [14]. Analyzing the biological and abiological factors, the effects of dam construction to the river ecosystem are as follows.

2.1. Flow Influences as Dam Constructions

Dam acts as a barrier between the upstream and downstream habitat of migratory river animals, such as Chinook salmon and steelhead trout in the USA [15], and Atlantic salmon in Europe [16]. Dams block their migration upstream to spawning areas, threatening to decrease reproduction numbers and reduce the species population. In light of this consequence, efforts have been made to allow the fish a passage upstream, and newer dams often use artificial “fishways” or “fish ladders” [17-19]. Some communities have also begun the practice of transporting migratory fish upstream to spawn via a barge. Fish sometimes have difficulty migrating downstream through a dam, meaning that downstream populations are often reduced unless the fish are able to swim safely through the dams’ spillways [18].

Permanent inundation caused by reservoir flooding also alters the wetlands, forests and other habitats surrounding the river. Further ecosystem disruption occurs along the banks of the river and downstream [20]. The areas surrounding riverbanks are of a particularly rich biodiversity, supported by the natural flooding of a dam-free river.

Dammed rivers reduce flood rates, and this has negative consequences on the floodplains downstream that depend on seasonal waters for survival. The invariable ecosystem created by a reservoir-river supports a far-reduced range of wildlife. Dams hold back sediments that would replenish down stream ecosystems naturally. Endemic species may or may not survive the environmental change, and new species are likely to adopt the altered habitat as a home. However, since dams change a key ecosystem to which all surrounding ecosystems have adapted. Dam construction nearly always reduces wildlife diversity, for better or for worse.

Dams are built to modify the timing and distribution of water. Operational rules are usually based on narrow economic criteria. Dam operators are interested in environmental conservation, but are unaware of the hydrologic needs of floodplain ecosystems. Flow variation should be guaranteed by flow regulation. According to arguments of hydropower opponents, reservoirs contribute to greenhouse gas emissions as well.

The flush flux will be changed by the need of power station to adjust the apex. The change ratio of the flush flux has an important effect on the downriver watercourse, and then affecting the habitat of riverside species [19]. The running river may become still pond, and change to the lake condition. Whether minimizing or increasing the current of flush flux, a diversion type power station may affect the conformation of river corridor, the botanic community and biologic habitat.

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2.2. Flooded Area Reduced as Dam Construction

Flood is the natural attribute of the river and flooded areas. It has an important effect on the continuous using of regional water resource and holding of flooded area scope and its function. The measures to prevent the flood and reduce the disaster include different and extensive strategies. Some of them may be out of line with the object of river corridor restoration. Floodwall makes the velocity of flow increased and water level heightened as water current was limited. When floodwall back off, we can put apart the river corridor as flooded area or temporarily flooded area.

Usually, the flooded areas are marshes, and it has important effects on purity of water quality and protecting of the biodiversity [21]. Compared with reservoir's submerged areas, the flooded areas are useable soil because it is only little periodical time overpass water on the flooded areas. What is more, floods bring nutrition and species as a supplement repeatedly. Nevertheless, dam construction changed the flood character of river.

In many developing countries the savanna and forest ecology of the floodplains depend on seasonal flooding from rivers. In addition, flood recession cropping is practiced extensively whereby the land is cultivated taking advantage of the residual soil moisture after floods recede. Dams attenuate floods, which may affect the ecology and agriculture seriously [22]. The disadvantages to the flooded areas are mainly as following: The marsh landscape of flooded areas reduced, biodiversity derogated, and ecological function degenerated and so on.

1) Marsh landscape reduced

Due to the hydraulic engineering including bank built and dam constructed control measures, the modes hydrological state and water cycle of flooded areas have been changed. It leads to the ecological environmental function degeneration of flooded area. In the plus effects of obstructed the contact of rivers and lakes. From 1950's, 82% of the flooded marshes of the middle and lower reaches of Yangtze River was lost [23]. Large-scale loss of flooded marsh landscapes has brought considerable negative effects. The effect of lake mirages of Yangtze River basin to the stream flow was greatly reduced [24].

2) Marsh biodiversity derogated

Dams hold back not only sediment, but also debris. The life of organisms (including fish) downstream depends on the constant feeding of the river with debris. This debris includes leaves, twigs, branches, and whole trees, as well as the organic remains of dead animals. Debris not only provides food, but also provides hiding places for all sizes of animals and surfaces for phytoplankton and microorganisms to grow. Without flooding and a healthy riparian zone, this debris will be scarce. In addition, although debris might come from the river above the dam, it is trapped in the reservoir instead, and never appears in downstream. The bottom level of the food web is removed. Overall, the loss of sediment and debris means the loss of both nutrients and habitat for most animals.

The environment changes of flooded area's habitat and the interdiction of river accesses brought about changes of birds and mammals amount. Gone with the loss of flooded marsh landscapes, more and more biological species were in danger or extinct as its survival and living spaces lost. It also lead to the propagate ability descended and the quantity and quality of species decreased or degenerated.

3) Marshes and its regions ecological function degenerated

The maintenance and reinforcement of the structure and function of flooded marsh ecosystem mainly enslaved to relative variability of flooded areas and instability of hydraulic and dynamic conditions [13]. The dam altered the hydraulic and dynamic conditions, which made the destroyed of flooded marsh environmental ecosystem. It further lead to the degenerated of regional ecosystem.

2.3. Species Changes as Dam Construction

Dam construction offered preferable conditions of aquaculture development. It also changed many dams to the aquatic serve base. However, dam still submerged lots of ground and blocked the relationship of river being network. It affected the inhere survival and propagate eco-environment of wildlife.

The first effect of a dam is to alter the pattern of disturbances that the plants and animals of a river have evolved. Many aquatic animals coordinate their reproductive cycles with annual flood seasons [25]. Every flood is valuable in that it takes nutrients from the land and deposits them in the river, providing food for the stream's

110 residents. Floods also provide shallow backwater areas on vegetated and shaded riversides; the young of many
111 animals depend on these backwaters to protect them from large predators.
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113 For example, a fish on a certain river may only reproduce during April of every year so that its offspring will have
114 abundant food and places to hide. If the flood never comes because a dam holds the river back, the offspring
115 may be produced during a time when they cannot possibly survive. If the fish can wait until the next flood, which
116 may be in July or October, its young will be born during the wrong time, and will have to contend with the
117 absence of their normal food supply and temperatures for which they are not prepared.
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119 Vegetation, too, depends upon these regular cycles of flood. Quite often, people will decide that they can spare
120 no water and no flooding will occur. On the other hand, they may have built the dams specifically to stop
121 flooding, so they can build houses in the floodplains. When this happens, riparian vegetation, the vegetation
122 bordering the river changes forever. An example of this may be found in Southwest United States [15], where
123 enormous floodplains of cottonwood and marsh have been replaced by dry, barren areas of tamarisk and grass.
124 The changes of habitat conditions affected the living rule, food chain, species movement, diffuse ranges and
125 spawn of hydrophilic. Parts of species decreased or disappeared as environment maladjustments. After dam
126 constructed, intrinsic river systems completed with allusions, beaches and watercourses became a relative erect
127 single watercourse. This reduced species of intrinsic animals and plants, will depress the biodiversity.
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129 1) The changes of inhabit and propagated environment

130 River level changes may cause some kickbacks to the water eco-environment followed by the modes of
131 hydropower need changes, such as river level rapidly changed caused the erosion of lower reaches of
132 watercourses. Alternately, exposure and submerged shallow may destroyed the rest locations of shoal and
133 disturbed shoal spawn and so on. Besides, river temperature changes also altered the survival environment and
134 lifecycle of the aquicolous species. Rivers tend to be homogenous in temperature. Reservoirs, on the other hand,
135 are layered. They are warm on the top and cold at the bottom. If water is released downstream, it is usually
136 released from the bottom of the dam, which means water in the river is now colder than it should be. Many
137 macroinvertebrates depend on a regular cycle of temperatures throughout the year. When we change that, we
138 compromise their survival. For instance, a certain stonefly may feel the cold temperatures and delay its
139 metamorphosis. This may mean that at a certain life stage it will be living in deep winter rather than in autumn.
140 Dams destroyed the habitat of parts of triphibian plants and made their biological resource changed. Dams also
141 affected the exchange of species and altered the habitat of lower river aquicolous animals and plants [26].
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143 2) Biological quantity and species changes

144 Dams weakened the flood peak, adjusted the water temperature and reduced the diluted function of lower
145 reaches of a river. It caused the increase of plankton quantity and distributing character and amount changes of
146 invertebrate. Dams reduced the flood submerge and grass roots erosion. It increases sediment of nutritional
147 silver sand, which led large-scale water plant can be row and propagate. Owing to the head off much cobbles
148 and graves, the invertebrates such as insect, mollusks and testacean lost their living environment.
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150 3) The effect to the fish species

151 Dams shut off the migrate channels of some migratory fishes. As the released water has a low temperature by
152 dam deep hole, the growth and propagation of fishes may be affected. Released rinsing also influenced the fish
153 feed, which affected its output. When high dams overall and flood discharges, high speed current caused
154 excessively saturation of the water. Moreover, it caused fish bleb disease. For instance, the Gezhou Dam on the
155 Yangtze Rive, it has a flush flux of 41300-77500 m³/s, and the oxygen saturation: 112-127, nitrification
156 saturation: 125-135%, lethal ratio of par: 32.24% [27].
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158 The fish passage is concerned with dams. Many fishes must move upstream and downstream to complete their
159 lifecycles. Dams are often built without fish ladders. When fish ladders are provided, they seldom work as
160 needed. If enough adult fishes do manage to climb above a dam, there remains the issue of their young: how
161 will they get back downstream? Predators kill many while wandering in the reservoir above the dam. Many are
162 killed in their falling downward through the dam to the river below. They are not killed by the fall itself, but by
163 the high levels of nitrogen gas at the base of the dam [28]. In other words, like divers who go too deep, they get
164 the "bends". (...)

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1. **In the introduction, the author states that:**
 - a. The construction of dams has only advantages to the environment.
 - b. The repair of rivers prevents disasters.
 - c. **Dams can reduce the risk of flooding.**
 - d. While dams may change floodplain hydrology, aquatic and floodplain biota are not affected.

2. **Which of the following is NOT true, according to Section 2.1:**
 - a. Migration of salmon and trout is affected by dam construction.
 - b. Artificial pathways in newer dams mitigate the blocking of migration routes of some fish.
 - c. In some places, people take fish upstream on boats across the dam.
 - d. **Downstream migration is not affected by dams.**

3. **It IS correct, according to the author (Section 2.1):**
 - a. **Ecosystem disruption occurs along the banks of the river both upstream and downstream when a dam is built.**
 - b. Biodiversity is not affected by the construction of a dam.
 - c. Wildlife diversity in floodplains downstream is not affected by a dam.
 - d. Currently, dam operators mimic seasonal flow changes in order to guarantee biodiversity.

4. **The construction of a dam will influence the flow rate of the river downstream. Which of the following is NOT according to the author views as negative consequences to the river ecosystem:**
 - a. Migration of river animals is blocked which decrease reproduction numbers and reduce the species population.
 - b. The areas surrounding riverbanks, rich in biodiversity, is affected due to the change in flood-rates.
 - c. Down stream areas will have fewer sediments to replenish the ecosystem.
 - d. **Flow variation is guaranteed by flow regulation, and is based on economic criteria.**

5. **Mark the following option that is NOT according to the author in Section 2.2. The flooded area in dam-free areas:**
 - a. Improves the quality of the water and protects biodiversity.
 - b. Produce nutrition rich soil and residual soil moisture that can be used for cropping during some seasons.
 - c. **Produces derogated biodiversity and degenerated ecological function.**
 - d. is important to ecology and agriculture.

6. **In line 63, the phrase "it has an important effect" refers to:**
 - a. Dams
 - b. **Floods**
 - c. Rivers
 - d. The dam reservoir's submerged areas

7. **The "reduced marsh landscape" (lines 74-80) was caused by:**
 - a. **Measures used to control the water levels of dam reservoirs.**
 - b. Hydraulic engineering within the dams' spillways.
 - c. Heightened water level downstream.
 - d. Reduced debris (leaves, twigs, branches, and whole trees, as well as the organic remains of dead animals).

8. **The main cause of "marsh biodiversity derogation" downstream caused by dams (lines 82-94) is because, according to the author:**
 - a. Dams hold back sediment.
 - b. Dams are a barrier to fish.
 - c. **The bottom level of the food web is removed, leading to loss of both nutrients and habitat for most animals.**
 - d. Degradation of the purity of water.

9. Mark True or False (T/F) to the following statements, according to Section 2.3.

- () Dams endanger aquatic animals that coordinate their reproductive cycles with annual flood seasons.
- () Dams affect how much nutrient is transferred from the land to the river.
- () Dams endanger predators that depend on shallow backwater areas on vegetated and shaded riversides.
- () Animal's offspring will not because dams hold back floods and, consequently, food and places to hide.
- () The living rule, food chain, species movement, diffuse ranges and spawn of hydrophilic are affected by the lack of floodplains.

VVFVV

10. Mark True or False to the following statements to lines 129-165.

- () The temperature of the water released downstream is colder than in the dam-free river, compromising the survival of macroinvertebrates.
- () Various plants have been endangered by the destruction of the habitat in lower river.
- () Dams decrease the population of plankton.
- () When flood discharges high speed current can cause excessive saturation of the water leading to fish bleb disease.
- () Fish ladders are effective to maintain migration routes of fish upstream.

VVVVF