

Sustainable solutions for flood control infrastructures in Indian context: A critical review

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Abstract

Flood is a common disaster for many countries, which occur yearly or during monsoon season in any part of the world. Recently the demand of safety from floods has increased around the world. For eliminating the effects of floods, the best way is to go through a natural way. With this background, a literature review was carried out in the Indian context to study the key tasks involved in flood control and the sustainable solutions for preventing the flood disaster in a natural way, without harming our earth planet. This paper concludes that the SD solutions are effective but it will take little longer time to restore our natural ecosystem back in future.

Keywords: Sustainable development, flood control, flood control infrastructure, green infrastructure.

1. Introduction

Sustainable development has become a very essential element for human life ever since our environmental conditions start degrading in many parts of the world. Sustainability in every aspects related to our environment is now-a-days a priority for the betterment of the life to exists on the earth surface. As our earth is continuously deteriorating due to imbalance in our environment and our natural resources are also at stake. Hence sustainable development is required everywhere for saving our beautiful and precious earth planet. Our major aspect of sustainability is required especially in our water resources specially those which are on the surface of the earth planet. As these water resources are at risk when there is a condition of either a scarcity or a flood. In this paper sustainable development for the control of flood is extensively studied.

A sustainable development has a specific objective or goal of providing a development in any domain. A flood is considered as a natural disaster but only few agree that it is caused by many other factors. A flood control structure such as a dam is a major infrastructure in controlling flood followed by other structures such as weir, barrage, etc.

The understanding of the causes of the flood is of utmost important for controlling it. As the crucial factors involved in causing floods are many but the key parameters are essential in controlling the flood. The first thing is to identify the key parameters. For identifying key parameters, spatial exposure analyses support and feasible detection of hotspots at National scale based on spatially explicit data is required as per [1].

Many flood risk management plans are developed for acquiring sustainability in flood domain. And for developing the flood risk management plans, first thing required is to collect the data. The information is collected by both in-depth interviews and questionnaires to key stakeholders. And the results shows that improving the coordination and including better land-use planning approaches are preferable with the green infrastructure development [2].

Some researchers have collected the data from the general public as well as expert peoples through interviews. The surveys which are conducted by [3] revealed that floods present a series threat in the eyes of the inhabitants and that the perception of threat depends to a certain degree on the place of the residence. The surveys also highlighted the other measures, solidarity and the importance of insurance against floods. Based on the actual expert's risk assessments [4], a high and a low risk area were selected and the risk perception was assessed on the basis of scaled items regarding storm surges.

The interviews with social and natural scientists reveal vast disparities in estimates of the economic impact of potential greenhouse warming [5]. They [6] have integrated social research data into flood risk analysis with the aim of supporting decision making on non-structural measures. They [7] developed a flood risk management plan based on integrated approach of analytic hierarchy process (AHP) and the geographic information system (GIS).

Flood management decision making can be defined as a multi-objective, multi-participant problem where alternatives are evaluated against a number of objectives considering the concerns of all stakeholders. Fuzzy set and fuzzy logic techniques [8] have been used successfully to prevent vague, imprecise information in many fields so have been considered as an effective way to represent uncertainties.

According to [9], the flash flood forecast and warning communication, interpretation and decision making, using data from the survey of the general public. The analysis elucidates the complex, contextual nature of protective decision making during flash flood threats. They suggests that warnings can play an important role not only by notifying people that these is a threat and helping motivate people to take protective action, but also by helping people evaluate what actions to take given their situation.

As per [10], expanded monitoring of floods, improved mitigation measures, and effective communication with civil authorities and vulnerable populations has the potential to reduce loss of life in future flood events.

2. Recommendations for flood management practices: -

Flood management practices involved three major processes: Public education, communications and warning systems and the Decision support system (DSS).

2.1 Public Education programs:

According to [6], public education programs should be provided to the general public for their safety during floods. This could be done through annual information campaigns and workshops for action forces and the public. There should be a provision of website with

updated information and advice to the public. And the awareness programs about the flood warnings and signs and hoardings should be provided to the general public.

2.2 Communications and Warning systems:

The early and timely communication of relevant information in flood emergency plays an important role in saving life and property. As per [3] and [6], the various components of warning systems are derived, such as daily reports at a specific office or a centre, flood risk prediction or prediction of heavy rainfall, preparation of flood maps for identifying the areas under threat, specific warning messages on internet or hoardings.

2.3 Decision Support System:

The Flood forecasting should be integrated with Decision support system (DSS) for flood prevention [3]. The flood forecasting with a lead-time of longer than 1 to 3 days ahead is required by flood scientists to identify key risk areas as well as for fast decision making process.

Table 1: Key tasks for preventing damages derived from [11]

Sr.no.	Key Tasks	Description
1	Understanding	Understanding the phenomena of flood.
2	Identifying	Identifying the key factors involved in causing flood.
3	Planning	Hazard and risk mapping of the area. Planning and construction of structural protection measures. Reduction of land-use planning in flood prone areas in the municipalities.
4	Implementing	Operation and maintenance of flood control structures. Warning and forecasting of floods.
5	Evaluating	Assistance of action forces and police in emergency situations. Inclusion of green infrastructures for reduction of floods through natural way.

As floods in India are classified into five categories, so DSS should be different for each category. The five categories according to [12] are none, minor, moderate, major and severe. In the first category of none, no threat of flood warning is given because there is no flood in the vicinity as per the flood scientists. In minor category, minor flooding in some areas occur which causes some inconvenience to the public. In moderate category, inundation of low-lying areas occur causing disruption of roadways but not railways and airports. In major category, inundation of large areas occur causing disruption of road, air and railways and it also requires evacuation of some areas. And in last category of severe flood, large scale inundation of many parts of the cities occur causing major disruption of rail, road and air ways. And it also requires evacuation of people on larger

scale. Due to this category, the towns, cities are cut-off from the other parts of the country.

According to [11], there are total five key tasks for preventing damages from flood. For understanding flood, various surveys are done. The surveys are either for getting feedback from general public, key stakeholders or expert people opinions. Next task is identification of key factors or physical hotspots in causing flood. Next task is planning, which can be done through hazard and risk map planning, planning of land-use plays a significant role. And then comes implementing the task and finally evaluating it.

Table 2: Sustainable development solutions derived from [12] and [13].

Sr.no.	SD solutions	Remarks
1	Rain Gardens	Incorporated in planning for public parks and on-site storm water management.
2	National action plan	Followed by state level and local action plan. Early Warning system and communications.
3	A forestation	Whenever land acreage is available.
4	Strategies for large rivers	Structural measures: operation & maintenance.
5	Green infrastructures/ Eco-friendly infrastructures	Green buildings
6	Eco-friendly cities/ towns	Replacing of rigid pavement roads with flexible permeable roads

Sustainable flood management requires an integration consideration of ecological and social consequences of disastrous floods. According to [12], rain garden plays a significant role in SD. The rain gardens will be incorporated in planning for public parks and on-site storm water management for larger colonies and sites that are to be developed. The next SD solution is National action plan on climate change followed by state level and local level action plan, is a broad based thinking as per [13]. A forestation is required whenever any land acreage is available; this will help in restoring our ecological balance. The strategies for large rivers [11] are structural measures such as dams, levees, super levees, flood diversions, channel improvements, upstream sediment control. Proper and timely operation of the hydraulic structures or control structures could be done by developing a proper proforma for discharging of water to be linked with the quantity of discharge of water (inlet). And the channel improvements can be done through two ways: lined channel and flexible channel. In the lined channel, rigid linings will be implemented in high density urban areas where space is a constraint and flexible linings will be provided in medium and low density areas and new developments, as these permit infiltration and are environmentally friendly, providing habitat for flora and fauna [12]. Non-structural measures also play an important role such as flood forecasting, warning, evacuation and community self protection teams.

As our natural ecosystem is the only sink here, which can effectively reduce but now it will take little longer time due to the imbalances in nature. Ecosystem balance should be maintained by increasing green infrastructure. Now-a-days various green infrastructure

mechanisms are there such as green buildings flexible road pavements. This will help in delaying all the flood process, which in turn will help us to think and shift to a safer place meanwhile in emergency situations.

3 Conclusions

The increasing demand for the safety from the floods has become a major challenge now-a-days for the Government of the countries. Flood disasters are not a new word for many countries around the world. In India floods occur in every year in many parts of the country destroying lots of the property as well as precious lives of people. As there are many rivers in India flowing dangerously specially in monsoon season despite of provision of huge flood control infrastructures.

This paper gives certain key tasks or benchmarks which are required for managing floods in rivers. And the Sustainable development solutions for flood prevention is explained here are effective as here the solutions are related to our natural environment. Hence, if these solutions are implemented than the flood prevention can be done very easily without evacuating or disturbing anyone.

4 References

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