Effect of extreme events on urban rivers: Case of Mumbai, India

Quels effets des événements extrêmes sur les rivières urbaines ? Le cas de Mumbai, Inde

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RÉSUMÉ

Mithi est la plus grande rivière de Mumbai, la capitale de l'État de Maharashtra en Inde. La rivière a subi de nombreuses transformations du fait de l'urbanisation. Avec l'expansion de la ville, les plaines inondables des rivières ont été occupées, réduisant de fait la voie navigable. En outre, en raison de l'absence de système d'assainissement, les eaux usées et les déchets non traités de la population croissante sont rejetés dans les rivières. Le 26 juillet 2005, le bassin versant des rivières a reçu 944 mm en 24 heures. Cela a entraîné le débordement de la rivière Mithi sur ses rives, causant plus de 450 morts et de graves dégâts à la ville. L'aéroport international de Mumbai a également été inondé et fermé pendant plus de 72 heures. Cet article décrit les travaux d'amélioration de la rivière pour réduire l'effet des précipitations extrêmes. Les mesures prises pour améliorer la qualité de l'eau de la rivière Mithi sont également décrites. Enfin, nous aborderons le plan d'action jusqu'en 2034.

ABSTRACT

Mithi River is the largest river in Mumbai, the capital of Maharashtra State in India. The river has undergone several transformations due to urbanization. As the city expanded, the flood plains of the rivers were occupied and reduced the waterway. Also, due to absence of sewerage system, sewage and untreated waste from the increasing population are discharged into the rivers. On 26th July 2005, the rivers' catchment area received 944 mm in 24 hours. This resulted in the Mithi River overflowing its banks thereby causing over 450 deaths and severe devastation to the city. The overflows also flooded the adjoining Mumbai International airport which was closed for over 72 hours. This paper describes the subsequent river improvement works to reduce the effect of extreme rainfall. Measures undertaken to improve the water quality for the Mithi River are also described. Future action plan till 2034 is also described.

KEYWORDS

Extreme event effects, Mitigation, Mumbai, Restoration, Urban River

1 INTRODUCTION

Mumbai is the financial and film capital (Bollywood) of India generating 6.16% of India's GDP and accounting for 25% of industrial output, 70% of maritime trade in India and 70% of capital transactions to India's economy. It is also one of the world's top ten centres of commerce in terms of global financial flow and Mumbai's employment opportunities attracts migrants from all over India thereby leading to overcrowding and proliferation of slums. It is estimated that over 65% of Mumbai's population lives in slums, mostly in low lying areas or on hill slopes, making them highly vulnerable to flooding and landslides during the monsoon. Mumbai receives over 95 % of its rainfall during the monsoon during June to September with very little rain during the rest of the year. The average annual rainfall of Mumbai is 2354 mm (MCGM, 2017). About 75 % of the AAR occurs in July and August and 50 % in just two or three events. However, on 26th July 2005, the Santa Cruz observatory of the IMD recorded 944 mm of rainfall in 24 hours out of which about 478 mm occurred in just 5 hours (Gupta, 2007). It was seen that at the time of the flood, the Mithi River waterway was severely encroached and polluted due to wastewater discharges from the slums and industries adjoining the river banks. The river flows for 17.8 km before merging into the Arabian Sea. Immediate action after the floods was to allot works to the two organizations - The Municipal Corporation of Greater Mumbai (MCGM) for the upper reaches (11.8 km) and the lower reaches (6 km) to the (Mumbai Metropolitan Regional Development Authority (MMRDA). Of the entire stretch, the Municipal Corporation of Greater Mumbai is tasked with looking after 11.8 km (from Vihar Lake to CST bridge) while the Mithi River Development and Protection Authority has to oversee the remaining 6-km stretch. This paper describes the works carried out in the upper reaches of the Mithi River to enable the river to carry 100 mm/h occurring for 3 hours and the future environmental plans for river restoration and development.

2 MATERIAL AND METHODS

In this section, we briefly describe the methods adopted in the project and case studies.

2.1 Case Study- Brief description of the Mithi River

The Mithi River is a natural river formed from the overflow of Vihar lake and receives the overflows from the Powai Lake and various other stormwater drains in its brief length of 17.8 km. It flows through various residential and industrial areas as well as under the Mumbai international airport main runway, the commercial centre Bandra-Kurla Complex and Dharavi and Mahim, before it joins the the Arabian Sea at Mahim Creek. It is estimated that in the dry period during November to April, the stream consisted of 93 per cent domestic sewage and seven per cent industrial waste (Maharashtra Environment Minister Ramdas Kadam, July 2015). Mithi is the most polluted water body in the city, according to the Maharashtra Pollution Control Board's water quality assessment report that highlighted the extreme increase in Biochemical Oxygen Demand in the river water - against the standard 3 mg/l, the level found was between 33.7 mg/l and 71.7 mg/l. However, during the monsoon, it drains stormwater from its catchment of 72.65 sq km. and BOD levels are less than 3 mg/l due ot the high volume of stormwater flows.

2.2 Methods

After the Mumbai floods of 2005, several hydrological and hydraulic studies were carried out by the authors. The methodology consisted of collection of hydrologic data, delineation of catchment, computer simulation and computation of final channel widths and depth. In addition, separate computer simulations were carried out for the design of airport culvert using HEC-RAS v4.0 (USACE, 2010).

3 RESULTS AND DISCUSSION - CURRENT STATUS AND FUTURE PLANS

During 2007-2010, the widths of the river were increased to 20m, 35 m. and 60 m in the upper, middle and lower reaches respectively. The Mithi River waterway passing under the airport runway for a length of 400 m has been widened from 27m to 51m by constructing two additional culverts each of 12 m width. In addition, two detention ponds to store an estimated 3000 m^3 each - one on-line and one off line have also been completed on the Mithi River in the upstream. In the process, about 3800 illegal

structures were demolished to restore the flood plain of the river. Widening and training of feeder drains and railway culverts from existing 4-10 m. width to 7-14 m. and rehabilitation of 277 encroaching structures on the 1.6 km-long stretch have been implemented.

This has greatly enhanced the flow carrying capacity of the river and it was observed that during the heavy rainfall event of 19 August 2017 (314 mm in 4 hours), the river did not overflow in the upper reaches where the above mitigation works had been completed.

An estimated EU 70 million have been spent on widening and deepening the Mithi river in the last 12 years, however, keeping the river clean has been one of the biggest challenges for the Municipal Corporation of Greater Mumbai (MCGM). The sewage emission from the nearby slums in Kurla has increased the pollution level in the river. To address this concern, the MCGM has proposed two sewage treatment plants (STPs) to be installed in the slums. The proposed projects will be included in the Draft Development Plan (DP) of Mumbai 2034. The STPs have been proposed to be installed on the land next to Mithi River in Kurla (L ward) which has been transferred from the MMRDA to the MCGM - The total area of the land handed over is 137 hectares, which includes L ward, H-West (Bandra west) and K-west (Oshiwara area) of which 35 hectares are in the L ward.

To mitigate flooding around Mithi river especially in Kurla, the development plan 2034 has reserved areas for three pumping stations.

The quantum of work completed in restoring the river varies from 70% to 95%. Civic engineers consider removal of encroachment, land acquisition and rehabilitation as the major challenges in restoring the rivers. Several housing societies still abut the Mithi River. Excavation for widening the river in such location has to be done carefully to avoid damage to the foundation of the buildings. To reduce the sewage contributions in the Mithi river, parallel interception sewers and sewage treatment plants have been proposed to treat the water before discharge it into the river.

4 CONCLUSIONS

The Mithi River was a natural water channel. However, urbanization has taken its toll with rapid developments in the Mithi River catchment as well as in the river's flood plains. The July 2005 floods have shown that river flood plains must be kept free of habitations to avoid loss of life and property. An eco-friendly solution would be to develop the flood plains as green recreational areas so that no loss of life and property will occur during extreme rainfall. The authorities are currently working together in this direction to make this a reality.

Acknowledgements

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