Urban Floods: Case Study of Hyderabad

Kalpana Markandeya and G. Suryanarayana

Profile of the City

Hyderabad is located in the heart of the Deccan plateau between 78° 22' 30" East Longitude and 17º 18' 30" and 17º 28' 30" North Longitude. Mohammed Quli Qutub Shah the fifth king of Golconda founded this historic city in the year 1591. Not only does it occupy a central location in the Deccan and by extension South India, but it also occupies a strategic location in the country lying as it does on a major highway of intersection between the northern and the southern part of the country. Established as a city with a single core, it evolved as a bi - nodal entity with Secunderabad as its twin city. It is surrounded by Rangareddy district on all sides, in which the impact of the spatial spread of the city is felt.

Hyderabad is the fifth largest and one of the fastest growing cities in the country. The urban agglomeration has increased enormously in size, from 245 sq. km in 1971 to 1865 sq. km in 2001 and in population from 1.8 million to 6.14 million. It is the second largest city of India with respect to area. The Greater Hyderabad Municipal Corporation (GHMC), which constitutes erstwhile Municipal Corporation of Hyderabad and erstwhile municipalities all around, is spread over 625 sq.km. and has a population of 5.33 million as per the 2001 census. Rapid urbanization and industrialization have brought about unforeseen changes in land use, burgeoning rural-urban migration, increasing pressure on civic infrastructure and environmental degradation.

Demography

The population of the city has grown fast especially after independence in 1947 (Fig. 1), owing to large-scale migration especially from the coastal districts of Andhra Pradesh. However, the primacy of the city in Andhra Pradesh, has come down, as has its position in the hierarchy of large cities of India. During the feudal era, Hyderabad was the only large city in the region; after independence, other cities have also grown at fast pace, due

* Contributed as Hyderabad city team under National Coordination Project of NIDM (Anil K Gupta and P.G. Dhar Chakraborti, Disaster & Development, 3 (1): 1-14,2009).

to the infusion of secondary and tertiary activities, to make the urban landscape of the state poly nucleated.

Hyderabad was the fourth ranking town in what is now India, from 1901 to 1941. With the rapid increase in the population of Delhi by 106.58 percent during 1941-51, Hyderabad came to occupy the fifth position in the post-independence era. This fifth position was maintained through 1971. During 1971-81, Bangalore and Ahmedabad, the two industrial cities, registered a very rapid increase, (75.56 and 45.31 percent respectively) overtaking Hyderabad in the ranked array. Hyderabad could not keep abreast with the growth rates of these two metropolises, which had stronger industrial base to begin with and hence there was retrogression in its rank to the seventh position in 1981. In 1991, it reclaimed its fifth position by registering a 67.86 percent population growth. But the recovery was more apparent than real. The main reason for this rapid growth was the inclusion of a large number of independent towns like Ramachandrapuram, Patancheru, Shamsabad etc. in Hyderabad Urban Agglomeration (HUA) in 1991 (Gopi, K.N. and Markandey, Kalpana,1994). The fifth position has however been retained by the city even in 2001 (Markandey K, forthcoming).

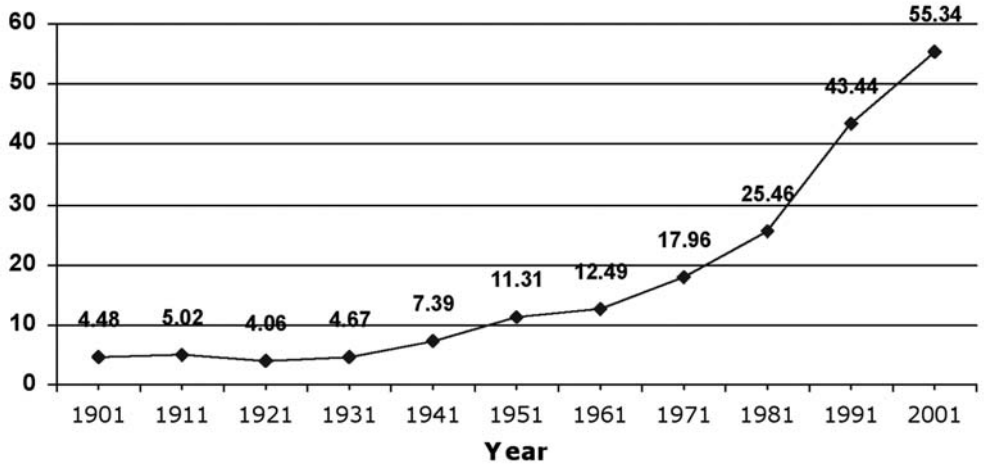

Figure 1: Growth of Population 1901-2001

Source: Census of India 2001

Hyderabad Urban Agglomeration (HUA) consists of the Municipal Corporation of Hyderabad (MCH), 12 peripheral municipalities, Secunderabad Cantonment, Osmania University etc. It has grown faster than Mumbai, Kolkata and Chennai during 1991 -

2001. The population density is also higher than that of Chennai, Kolkata and Bangalore. A perceptible feature of population growth in the surrounding areas has been that most of it is taking place on the periphery. The population growth in the surrounding municipalities during 1981 - 91 was 158% as against that of 42% in the MCH. Between 1991 - 2001 population growth in surrounding municipalities was 72% as against that of 19% in the MCH. Most of the growth has taken place away from the core of the city. It is expected that high rates of population growth will continue into the future as well and the HUA population would reach 77.2 lakhs in 2011 and 108.9 lakhs in2021. It has been found that the contribution of natural growth vis a vis that of migration in the overall population growth of the city had escalated in the year 2001, implying thereby that 'long term and strategic planning' is needed 'to promote equitable growth and service delivery'. (http://www.ghmc.gov.in/cdp/chapters%202.pdf)

Settlement Pattern

The city had a modest beginning. It originated as a trading center at Golconda on the route that linked Aurangabad with Masulipatnam. The most densely built up area was within the fortress - Golconda on the extreme west. With the passage of time the fortress town decayed and before the 19th century began, the nobility had shifted to the southern side of River Musi. Though the main axis of the city remained east-west, a northerly extension along the road north of the Charminar became quite visible. Once the Secunderabad Cantonment came up in northern Hyderabad in 1798, a second nucleus of the city started developing. It was named Secunderabad in 1806 after the then Nizam- Sikandar Jah. The Cantonment initially developed in an east-west direction, but later took on a north-south direction, in response to the stationing of the troops. The Cantonment consisted of the troops and the civilians employed by the British, and the businessmen who sold some of the imported commodities to the rest of the population of Hyderabad. This part of the city was distinct from its southern counterpart in language, culture and economy, yet the two grew together and towards each other (Alam S.M.1965, in Markandey K, forthcoming).

The setting up of the British Residency in the heart of Hyderabad in 1806, lent a new dimension to the growth of the city. Commerce coupled with churches and schools in close vicinity started sprouting up in this part of the city. In due course of time it developed a Central Business District (CBD) of its own. The coming of the railways in 1874 and their further expansion subsequently, brought the twin cities still closer to each other as well as integrating them with the far flung areas that now constitute the hinterland of Hyderabad. The trade links of Hyderabad also shifted from Masulipatnam

to Mumbai and Chennai. The axis of the growth of Hyderabad moved from east-west to north-south in response to the expansion of the rail network. South Hyderabad, however, fell into a lull and it took time before the recovery began in the mid-twentieth century.

The growth axis of the city was also influenced by the location of the high-class residential areas of the city. These areas were located close to those of the ruling classes in order to satisfy the snob appeal of the upper echelons of the society and also to provide a physical proximity in the event of any unforeseen contingencies. To begin with, these areas were in and near Golconda. When the center of power shifted from Golconda to Hyderabad, the Charminar area, which was developed on a grid-iron pattern, became the prime attraction. The houses of the nobles were located along the four main roads that diverged from the Charminar.

When the Nizam shifted his residence to the King Kothi area in the eastern part of the city core in 1912, the upper income groups also shifted and started living in the central and western parts of the city, which includes Raj Bhavan, the Governor's Residence, in the post- independence era (Alam, S.M. and Pokshishevsky, V.V.1976). Subsequent developments have been concentrated in the western part of the city including the residences of the 'leaders of the society'- industrialists, politicians, administrators and film personalities.

Apart from this area, the Secunderabad Cantonment, with its colonial ambience has been developing as a high-class area of limited spatial extent. The Banjara and Jubilee Hills areas as well as Secunderabad are ranked high on the scale of preferences by the city residents so far as the choice of residence location is concerned as well as with respect to facilities, amenities, physical and social environment, ease of travel and recreational facilities (Markandey K, forthcoming).

Climate

Hyderabad is not known for its pleasant climate. This is notwithstanding the fact that in the previous century Secunderabad Cantonment was known as a 'non-fan station' by the British. The climate of Hyderabad is generally hot and dry and is characterized by seasonal variations of winter from November to February, summer from March to June and monsoons from July to October.

The annual range of temperature varies from 120 to 420 C. The average maximum temperature varies between 400 and 440, the average minimum temperature varies 70 C and 100 C. Sky clearance factor is 50 to 70 except in rainy season, when it is above 20. The climate is more or less semi arid nature. But its perennial lakes subdue the harshness to

a manageable limit. The Southwest monsoon brings about average rainfall of 750 mm around June to September. July to September is the humid period. December and January are the months with the lowest temperature and high pressure (Op. Cit.)

Topography

The ground elevation in Hyderabad varies from 487 m to 610 m above mean sea level. The general gradient of land is from the West to the East. Rugged topography with isolated small hills is a feature of the western part of the city and flat plains mark the eastern part. Granite outcrops are a typical feature of this region and are seen on the outskirts of the city in ample measure. However, the construction activity in the city has taken a toll on the rocks which have been ruthlessly blasted in the recent past (Op.Cit.).

Hydrology and Water Bodies

The city is bisected into two, a northern part and a southern part, by River Musi, which is a tributary of River Krishna (Figure 2). In the event of heavy rains, floods are common; the largest of these occurred in 1908. The river was dammed and a reservoir formed to store drinking water for the city. The Osman Sagar Lake was constructed on the river Musi between 1912 and 1920. Subsequently, Himayat Sagar Lake was constructed between 1920 and 1927 on the stream Musa, a tributary of Musi. Before the construction of these two major reservoirs, Musi had a catchment area of 729.6 sq.km. and Musa had 1295.36 sq.km.

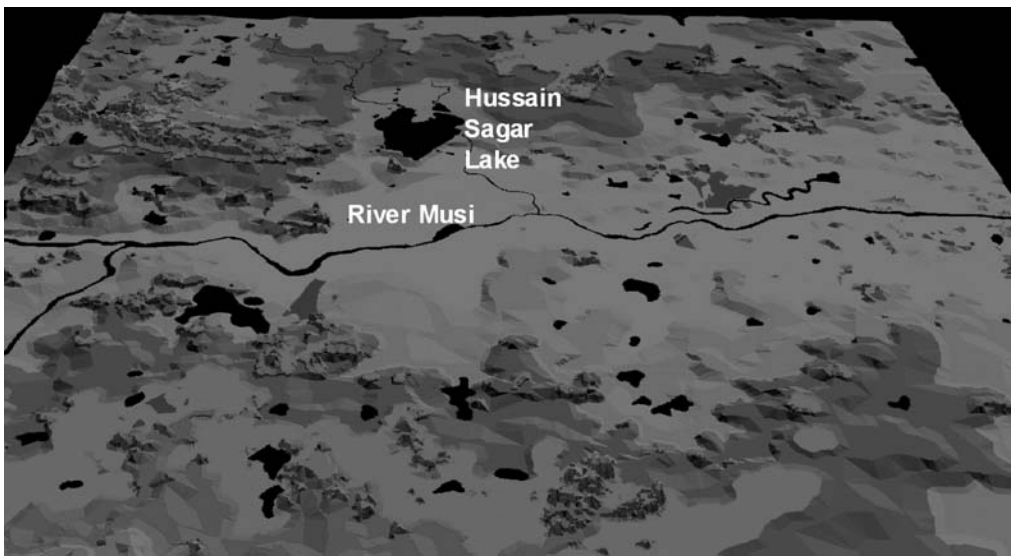

Figure 2 Topographic Profile of Hyderabad region

After these reservoirs were constructed, about 351.63 sq.km. of basin area drains into Musi bringing waste waters from Hyderabad agglomeration into the river. River Musi, which flows through the city takes on a very narrow course and dries up in this stretch, except for the city sewage flow. The water in the river in this stretch is not suitable for drinking or bathing.

There are about 400 big and small lakes in the Hyderabad Development Area of 2200 sq.km. Out of these 169 lakes have more than 10 hectares of water spread and 231 smaller lakes have water spread areas ranging from 1 - 10 hectares (HUDA report on Management of Urban Lakes, 2005). These water bodies make the microclimates of Hyderabad, especially in summer months, more bearable and in winters, highly salubrious. Unfortunately, rapid development and man made structures have gnawed into many of these water bodies depriving the city of a pleasant environment.

City Infrastructure

Even for the erstwhile Municipal Corporation of Hyderabad, which comprises of 9% of HUDA area, the coverage of underground sewerage system is less than 70% of the area. Of the 10 adjoining municipalities, which now form part of GHMC, only parts of Lal Bahadur Nagar, Uppal, Qutbullapur, Gaddiannaram and Kukatpally have underground sewers. All other areas in HUDA depend on septic tanks. The present capacity of STPs in the city is 113 MLD at Ambarpet and 20 MLD at Khairatabad. It is proposed to construct about 14 Sewerage Treatment Plants to facilitate clean flow in River Musi by various agencies. It is estimated that water demand by 2020 is 2050 MLD resulting in sewage load of 80% of that water supply, which is nearly 1640 MLD.

There are about 117 kms of drains in erstwhile Municipal Corporation of Hyderabad. There are about 63 storm water drains in 10 surrounding municipalities, which now form part of GHMC, with a total length of 102.34 km.

The present per capita garbage generation in the city is around 500 grams per day. In the Greater Hyderabad Municipal Corporation area (comprising 625 sq.km.), the garbage generation is 3450 metric tones. This constitutes solid waste generated from 0.14 million households and sweeping of 7158 road lengths and common markets. There are about 4169 garbage collection points. About 400 metric tonnes of garbage per day is used for pelletization and production of power. The remaining garbage is land filled.

Land Use Changes

The land use of parts of what is now the Hyderabad Urban Development Authority Area was first surveyed by the Municipal Corporation of Hyderabad and the Director of Town

Planning in the sixties as part of the process of Development Plan preparation. Those surveys were limited to the MCH area.

After the formation of HUDA, base maps and land use maps were prepared by Hyderabad Urban Development Area (HUDA) between 1975 and 1980 for its entire jurisdiction for preparing the Master plan and zonal development plans. For the first time a Land Use Survey was carried out for the Metro areas. The first statutory Master Plan for Hyderabad Development Area (HDA) was brought in to force in the year 1980.

Since the 1984 base maps had become out dated, in 1999-2000 HUDA launched a joint project with the National Remote Sensing Agency (NRSA), Hyderabad to update not only base maps but also the land use maps for the non MCH area with the help of IRS satellite (LISS III + PAN) as well as ground verification in 2000. In 2002, existing Land Use data was received from the MCH, which was based on work done by consultants engaged by MCH for strategic planning for the MCH area.

Out of the total HUDA area of 18,647 ha., at present water bodies occupy 5%, open areas and parks about 1% and forest blocks and plantations about 6%. However, a study of the two imagery for 2000 and 2001 is presented in figure given below (Figure 3).

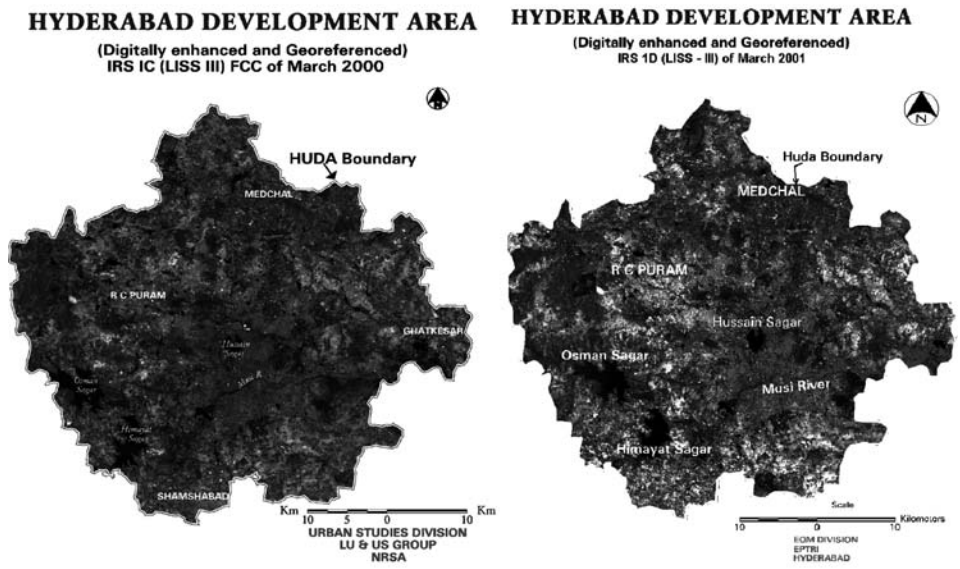

Figure 3

The Municipal Corporation of Hyderabad has witnessed a process of infilling of space leaving small proportion of vacant space in the city. Infilling has been more pronounced in the western, southern and northeastern parts of the city while the first part of the twentieth century witnessed an expansion along the northwestern and northeastern areas of the city. In response to the process of industrialization, the city witnessed growth in the west where Digital Economy finds expression in a large number of IT industries. The HiTech city in close proximity has produced marked infilling in the western part of the city by elite residential colonies. In fact the HiTech city or Cyberabad as the western 'exclusive enclave' is called, also mirrors a process of selective 'Nerdistization of urban spaces', where the people from the Information Technology sector are concentrated. Thus, this area not only has a concentration of the upper class of the city but also the newly upcoming middle class, a critical section of the society for the Digital Economy who look for a clean and healthy environment.

Extension of the built up area to the city limits is also witnessed in the southern of northeastern sides. In fact, the southern part of the city has experienced intense building activity in the past three decades, consequent to the remittances from the Gulf émigrés, members of whose extended families reside in this part of the city. The northeastern part, which is part of the Secunderabad component of the twin cities, has also witnessed a marked growth, which is phenomenally linked to industrial development along the north eastern corridor (Markandey K, forthcoming).

'The land use structure has been worked out *(by GHMC*) based on a survey and the activity centres present and future. The structure would help in limiting the decaying of certain areas through a conscious and judicious development of the core city and the peripheral wards, which have the maximum potential to grow in future. According to the survey, residential area constitutes 44% followed by 12% under open ground and agriculture. The mixed use is around 6.2 %.

There is also an increase in the institutional land uses than envisaged in the Zonal Development Plan (ZDP). The area under roads is also around 7% and considering the road widening initiatives, it would be slightly more than what is observed. It is quite evident from the analysis that there has been a modest increase in the mixed-land use, decreasing changes in industrial land use than that envisaged in the ZDP. This might be due to the successive industrial policies of the Government encouraging shifting of industrial units from the city. An analysis of spatial growth patterns in the past as well as for the future indicate saturation of growth in the core area, high growth and high densities in the surrounding areas along the industrial growth corridors' (http://www.ghmc.gov.in/cdp/chapters%202.pdf) . The same is presented in figure given below (Figure 4).

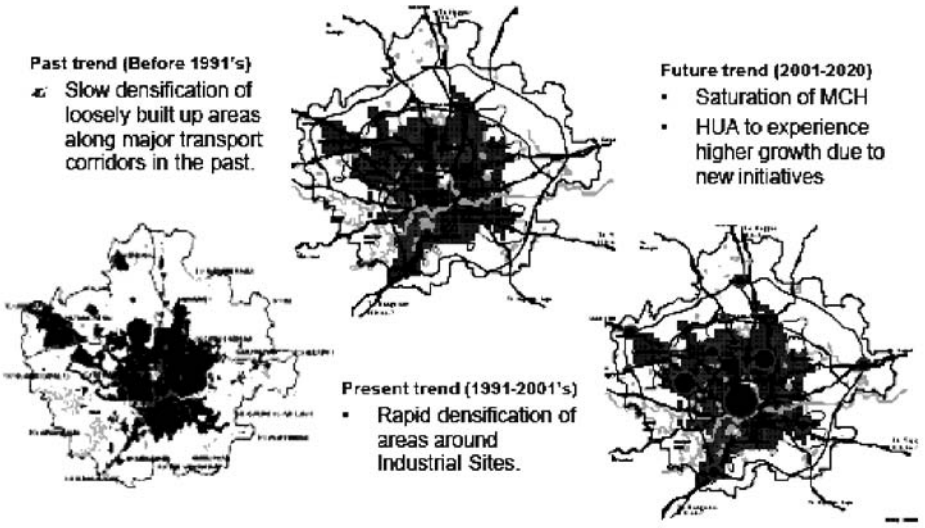

Figure 4

Source: GHMC http://www.ghmc.gov.in/cdp/chapters%202.pdf

Floods in the City

Hyderabad experienced unprecedented floods in the year 2000. The State capital, which experienced a record 263.6 mm and 246.2 mm of rainfall on 23rd and 24th of August 2000 - a 46-year record, wore a battered look with the gushing waters not sparing any area, not even the upmarket Banjara Hills and Jubillee Hills. The worst affected areas were Bowenpally, Safilguda, Maktha, Gandhi Nagar, Ashok Nagar, Bagh Lingampally, Chikkadpally, Rasoolpura, Begumpet, Viman Nagar, Indira Nagar, Hasmathpet, Trimulgherry, Lalaguda and Mettuguda. In Nadeem Colony near Toli Chowki, Army personnel rescued over 100 marooned families in boats. The casualties, mostly victims washed away in the floodwaters, were reported from Jubillee Hills and Chilkalguda (three deaths each), Chikkadpally, Kukatpally, Nallakunta (two each). (Deccan Chronicle, Aug. 24, 2000)

This act of nature, combined with urban geography and social structure, created the worst local disaster in half a century. At the heart of the city there is a large lake, the Hussain Sagar, the overflow from which is channelled via a canal to the nearby river Musi. Poor migrants from villages who came to the city 20 to 30 years ago in search of

livelihoods have settled in hutments along these waterways and other waste lands. There are now 1,000 slums in the city. Building and 'beautification' around the lake and encroachment onto the riverbed has diminished the natural flood and rainfall drainage area. This combination of factors has resulted in a human tragedy as massive flooding along the canal resulted in 77 slums being completely washed away. (www.hindustantimes.com/ photogallery/storypage.aspx)

Urban storm water runoff can cause the flooding of local rivers as well as of the urban area itself. Urbanization drastically alters the drainage characteristics of natural catchments, or drainage areas, by increasing the volume and rate of surface runoff. While the impact on major river systems may be minimal, the carrying capacity of small streams may be quickly exceeded, causing flooding and erosion problems. Often, the runoff from intense rainfall exceeds the carrying capacity of the storm water sewer system, creating a backup in the system and hence the flooding of basements and of roads.

Hyderabad is the new hub for software industry. However, these industries made an assessment that there is loss of revenue to the industry since many workers who lived in the flood-hit area could not make it to the office. Hyderabad suffered an estimated damage of Rs 700 crore in the year 2000 due to floods.

GHMC has engaged consultants, M/s.The Kirloskar Consultants Ltd., Pune (KICONS) to prepare detailed designs for modernization of storm water drainage system. After conducting the necessary studies, the consultants have identified the following as some of the key reasons for flooding in Hyderabad:

- Inadequate drainage system, designed for the rainfall of 12 mm/hour.
- Excessive concentration of flood due to breaching of tanks.
- Disappearance of flood absorbing tanks
- Dumping of debris and garbage into the open nallas.
- Illegal encroachment of natural water courses
- Patta lands in the natural water courses
- Springing up of housing colonies in the foreshores of the tanks.
- Sanctioning of layouts without reference to the ground levels.
- Indiscriminate laying of service lines all along and across natural water courses.
- Collection of building materials on the roadsides resulting in excessive silting of drains.
- Diversion of natural water courses to accommodate habitations.
- Increased run off due to increase in impervious areas.

The biggest reason for urban floods is the total lack of attention to the nature of India's hydrological system. It is known fact that heavy precipitation is inevitable every few years or so, it is essential that natural drainage channels are well-maintained and instead of encroaching upon and filling up urban lakes to use the high-value urban land for buildings, these lakes and tanks should be well protected.

Built in 1562, the storage capacity of Hussain Sagar tank, the city's biggest waterbody, is now half. Once the number of water bodies within the city was about 530, it has now come down to 150. Years of siltation of tanks have reduced their water storage capacity. Encroachment of nalas, lakes and other water bodies, choking of streams and stormwater drains have taken their toll. While hunting for scapegoats and blaming the central government and meteorological office, the Government admitted that encroachments were responsible for the floods.

Good Practices and Lessons Learnt

In spite of the suffering caused by floods, the spirit of the people was still strong and their desire to rebuild their lives was impressive as they sought to recover what they could. Local organizations had pitched in to help, including hotels, women's and youth groups who were cooking food in the streets and handing out clothing. More was needed and Oxfam, which has an office in the city, acted and is now working with its local partner NGO's to co-ordinate the relief and rehabilitation programme. These NGO's called everyone together and formed 'The Hyderabad Flood Relief Co-ordination Committee'. 4000 families in the slums had been identified as the most needy for immediate relief in terms of supply of food, utensils clothing and bed sheets.

Oxfam's is also looking at the long term by continuing its work with local partners The Confederation of Voluntary Organisations (COVA) who works on projects to promote communal harmony between cultural traditions in the city and the Campaign for Housing and Tenorial rights (CHATRI, umbrella in Urdu). CHATRI is affiliated to the Indian national campaign for housing rights and seeks to uphold UN conventions on the right to housing. Slum housing is often a contentious issue in Hyderabad where only 60% of tenure is legally held and even then tenants are liable to eviction as development schemes or 'beautification' projects envelope their neighbourhoods. Residents are reluctant to leave their ruined house in case they loose their tenorial rights. CHATRI is working with them to help stop evictions, to protect their legal rights and to ensure their needs for shelter will be addressed. (www.hindustantimes.com/photogallery/storypage.aspx)

Strategies for the Future

Strategies for the future in view of the inherent threat of floods could include:

- Unified Urban Flood management
- Flood Mitigation
- Land use and zoning plans which could be remedial and preventive
- Flood proofing of buildings, infrastructure etc
  - Including tank embankments
  - Prevention of houses in tank and river beds
  - Protection of tanks and lakes
  - Avoiding construction or granting of pattas in natural water courses
- Legal and Institutional measures
- Public Education and Participation
  - Against encroachment on lake beds
  - Against dumping of garbage in open water sources etc
- Encourage horizontal spread of the city rather than vertical as congestion, pollution etc generate a lot of hygroscopic nuclei which lead to heavy rainfall in select locations

Flood Mitigation

Flood Mitigation measures alter the exposure of life and property to flooding. It reflects the holistic nature of those flood management measures that do not have structural nature. Its non-structural nature led some countries to denote mitigation as institutional measures, while other countries preferred to use the name of best management practice (BMP). The latter is in use in urban conditions for many years. In Europe, the term SUD (sustainable urban drainage) is obtaining increased popularity.

Mitigating means planning, programming, setting policies, co-ordinating, facilitating, raising awareness, assisting and strengthening. It also involves education, training, regulating, reporting, forecasting, warning and informing. However, it does not exclude insuring, assessing, financing, relieving and rehabilitation. If structural measures are the bones of a flood management program, then mitigation is its flesh. http://unesdoc.unesco.org/images/0012/001240/124004e.pdf

Effort made to mitigate and manage the floods

Hyderabad has a decentralized system of disaster management in place. As per the short term programme, emergency teams have been set up to scout low lying areas and address necessary relief measures.

The Municipal Corporation has a call centre number 1913 functioning 24x7.

Since long-term planning is about getting things in place and making sure that they fall into place when the need arises, bad town planning is also identified as one reason. The numerous flyovers and mismanaged road widening has also come under flak.

The city planning unit had prepared a master plan in 1975 that was ratified and implemented by the government. The same year, HUDA was constituted and entrusted with the job of urban planning and development. Although they have prepared some general plans from time to time, finally a comprehensive master plan is notified recently.

The Municipal Corporation of Hyderabad (MCH) has begun remodeling and widening major storm water drains in the last few months. It has already completed work on 8 km of the 40 km identified for repairs in the first phase. The balance of 32 km is likely to be completed shortly. Kirloskar Consultants, appointed after the August 2000 floods, submitted a master plan covering major drains and primary, secondary and tertiary nalas for a total length of 170 km, suggesting widening, deepening and retaining of walls along open drains. A separate engineering wing in the name of 'Hyderabad Lakes and Management Circle', was formed after the floods to study hydrology of the water basin and its management. Some works have been taken up across Balkapur, Durgam Cheruvu, Begumpet and Murki nalas covering Langer Houz, Fatehnagar, Falaknuma, etc. As a part of this, necessary retaining walls were constructed with required widths and depths at places where there are less encroachments. It was reported that they had removed 500 encroachments and paid compensation to 60 affected parties.

Drain widths range from 2 to 50 metres while depth can be up to 7 metres. While 3,500 encroachments have been enumerated for the 40-km stretch, officials estimate the total encroachments to be twice for the entire 170 km. The Corporation received support from Government of India which agreed to grant Rs. 147 crores under the National Urban Renewal Mission and Rs. 47 crores under the Mega City Project. Officials estimate that the entire project costing Rs. 598 crores will be completed in three years.

Experiences of 2008 Floods

The fury of floods unleashed itself on Hyderabad yet again in August 2008. Within a span of two days, Hyderabad received over 15 cm rainfall. The city was not prepared to take heavy rains in a short span. The city recorded 12 cm of rainfall in less than 14 hours, the second highest rainfall in four decades. The city had recorded 24 cm of rainfall during the devastating floods in August 2000. Sources say that the city's drainage network

cannot take more than 1.2 cm of rain per hour whereas over 4 cm was recorded in less than an hour in August 2008.

Experts said lack of a disaster management plan is leading to such urban flooding. Lack of co-ordination among the GHMC, Hyderabad Metropolitan Water Supply and Sewerage Board, traffic police and other agencies coupled with improper land utilization has made the city more vulnerable to flooding.

Normal life came to a grinding halt in the affected areas. With some roads under water, vehicular traffic between twin cities remained paralysed. Hyderabad bore the brunt of the natural calamity with 14 people losing their lives, mostly in house collapses. As many as 52 residential areas in and around the state capital were inundated as twenty tanks and several major storm water drains overflowed. Boats were pressed into service in the city to rescue people from marooned areas. Even after the rains receded, hundreds of houses remained under water.

The vehicles movement was affected due to rain battered roads of the city. The average speed of vehicles in the twin cities of Hyderabad - Secunderabad came down to just eight km per hour as against the usual 14 km per hour, due to the bad condition of roads. The roads on LB Nagar-Miyapur and Secunderabad-Uppal sections faced the brunt of rains.

To add to the woes of motorists, more than 23,000 potholes appeared on the roads. There are 6,000 km roads in GHMC limits in addition to 250 km of State and National Highways running through the city.

Environmentalists have traced the recent flooding in the city to the irreparable damage caused to natural watersheds through unregulated urbanisation. These watersheds were buried in an overabundance of concrete structures and sought constitution of an independent body to manage "urban watersheds" by involving municipal and urban development authorities, academicians and NGOs.

According to them haphazard urban land use had increased both the magnitude and the frequency of floods in small drainage basins (of a few square kilometres) - a direct offshoot of lopsided water and land management practices. The rate of incidence of floods in urban areas was directly related to the extent of land covered with rough pavements and cement concrete - commonly referred to as impervious cover and shrinkage of open green spaces. The frequency of urban flooding had increased owing to unregulated urban expansion.

Roads inundated with water in September, 2008

Vehicles trapped in the storm waters

Marooned Colony during 2008 Floods

References

- Alam S.M. Hyderabad- Secunderabad: A Study in Urban Geography, Allied Publishers, Bombay, 1965
- Alam, S.M. and Pokshishevsky, V.V. (eds) Urbanization in Developing Countries, Osmania University, Hyderabad, 1976
- Balmforth, D. et al. Designing for exceedance in urban drainage -good practice. CIRIA 2006 in www.parliament.uk/parliamentary_offices/post/pubs2007.cfm
- Catch Water, The CSE Campaign for People's Water Management, Vol. 2 No. 5 October 2000)
- Gopi,K.N. and Markandey, Kalpana, Energy, Environment and Human Well-Being (Jointly with Prof. K.N.Gopi), Concept Publishing Company, New Delhi, 1994. www.ghmc.gov.in
- http://www.ghmc.gov.in/cdp/chapters%202.pdf
- www.hindustantimes.com/photogallery_storypage.aspx
- http://timesofindia.indiatimes.com/articleshow/1197284.cms
- http://unesdoc.unesco.org/images/0012/001240/124004e.pdf
- Hyderabad 2020: A Plan for Sustainable Development, Hyderabad Urban Development Authority, January 2003
- Markandey, Kalpana, Spatial Cognition in Urban Environment, Osmania University, Hyderabad, 1997
- Markandey, Kalpana, Urban Squalor as a Facet of Urban Landscape: Environmental Issues from Hyderabad, ISRO RESPOND Project Report, 2005
- Markandey, Kalpana,Hyderabad: A Twin City where Tradition and Modernity Intertwine, in Misra R.P. Million Cities of South Asia, Forthcoming
- Omer Farooq The Associated Press August 27,2000
- Postnote No. 289, Parliamentary office of Science and Technology, London, July 2007
- www.parliament.uk/parliamentary_offices/post/pubs2007.cfm
- Ramachandraiah, C and Prasad, Sheela, Impact of Urban Growth on Water Bodies The Case of Hyderabad, Working Paper, No.60, Centre of Economic and Social Studies, September 2004
- V.Ravi Kumar, P.K.Sinha and A.V.Satya Kumar Free and Open Source Geographic Information System for Urban Planning, GIS
- Rains claim 95 lives in AP Hyderabad, Aug. 24, UNI
- The Hindu, July 10,2006

Bibliography/ Webliography

Alikhan, Raza, Hyderabad: 400 Years, View Point, Hyderabad, 1990

Mujtaba, S.M. Landuse and Environmental Change due to Urban Sprawl:A Remote Sensing Approach, Daya Publishers, Delhi, 1994

http://www.hudahyd.org/html/bppa01.asp

http://www.apind.gov.in/mrtsproj.html

http://www.hudahyd.org/home.html

http://www.hudahyd.org/html/flyover.asp

http://www.hudahyd.org/html/urbanforestry.asp

http://www.hyderabad.co.uk/statistics.htm

http://www.unhabitat.org/programmes/uef/cities/summary/hyderaba.htm

http://www.ec.gc.ca/water/en/manage/floodgen/e_urban.htmhttp://en.wikipedia.org/wiki/Floods

http://www.uprct.nsw.gov.au/flood_mitigation/facts/pressure.htm

http://www.pbs.org/newshour/infocus/floods/science.html

http://www.redcross.org/images/pdfs/code/floods.pdf

http://www.nws.noaa.gov/iao/FFW/2006/Presentations/Session%201/Ab_29(1)_Arduino%20(Eng).pdf