Maintenance of Water Depth in Navigation Canals Versus Wetland System Loss- The Case of Canoly Canal, Calicut, Kerala, India

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Abstract

Inland navigation canals built during the Colonial Period in India, more often than not, connect distinct watersheds, and rely upon wetlands to sustain water levels required for navigation. This study addresses the impacts such navigations canals have on the surface flow patterns of the wetlands by analysing the case of Canoly canal and Kottuli Wetlands in Calicut, Kerala. The canal was constructed during the British rule in 1848. The canal connects two watersheds, that of the Kallayi river and Mangala river, linking both the estuaries and is geographically aligned to direct the flow of water from two wetland systems, Kottuli and Perunthuruthi to sustain water levels. Two thirds of the northern reaches of the canal falls in the Mangala basin and the southern part in the Kallayi river basin. The Kottuli wetland covering an area of 87.04 hectares is one of the 115 wetlands identified by the Ministry of Environment and forests, Government of India under the National Wetland Conservation Programme. Surface water from the wetlands flows into the canal through weirs while the groundwater seepage is generalised along the length of the canal. . Presently there are two proposed interventions for the canal. The Kerala Shipping and Inland Navigation Department's proposal to revive the West Coast Canal System, of which Canoly canal is a part, includes deepening and widening of the canal to ensure flow and to hold passenger and cargo vessels. The Irrigation Department proposes to deepen Canoly Canal to improve the flood drainage and domestic sewage into the canal. This scenario was analysed with respect to the drainage pattern of the region. A topographical map of 2m contour interval was prepared based on Google Earth imagery using Autocad. Surface drainage flow patterns were demarcated using Arcmap. Flow dynamics between the wetlands and the canal was documented with field observations. The study showed that the canal changed the flow pattern from the wetland. The outflow to the Arabian Sea has been diverted to the canal, both from the surface and the aquifer. This channelizes the flow, thus increasing the outflow and hence decreasing the water holding capacity. Further deepening of Canoly canal as proposed by the Shipping and Inland Navigation Department can result in outflow of water from Kottuli wetlands into the canal both from the surface and the aquifer; the extent of wetland loss will depend on the depth proposed for the canal. This will change the hydrodynamics of the wetland on which is the most important determinant for establishment and maintenance of ecosystem processes. The study recommends that this balance of water exchange needs to be understood and impacts quantified before any intervention that can potentially alter the hydrodynamics. Successful water management requires the adoption of methodologies which consider all bodies of water within a basin as opposed to just one body in a system.

STUDY AREA

Figure 1. Location N

Kozhikode (Calicut), is on the south west coastal belt of India (Fig. 1). The coast of the district is about 71 Km and the area is 91 square kilometers. Kozhikode city is the nodal point for the four districts in the northern region of the state of Kerala. Kozhikode has traditionally been developed as a centre for forest and agro based industries. It has a high order of development in trade especially in food grains, marine products and spices. The city offers high potential for development of the entire northern region of the state. In view of this, Kozhikode is considered as one of the priority cities in the state. (District Urbanization Report, Kozhikode, 2011). The district has a humid tropical climate and an average annual rainfall of approximately 300mm (Bazak and Nazimuddin, 1988)

Figure 2. Kozhikode district map and study area

Canoly Canal

The Canoly Canal is part of the West Coast Canal system and is situated in the city of Kozhikode (See fig 2). The canal was constructed during the British rule in 1848 under the orders of the then Collector, the administrative head of the region, Mr. R. Canoly. The canal is 11.4 km long, the width ranges from 6m to 20m and water depth in the peak rain period varies from 0.5 to 2m (Harikumar et al, 2004). Most of the length of the canal, except the northern part, is heavily urbanized (Fig. 3). The canal connects the Kallayi River in the south and the Mangala River in the north, passing through Kottuli wetlands and Perunthuruthi wetlands

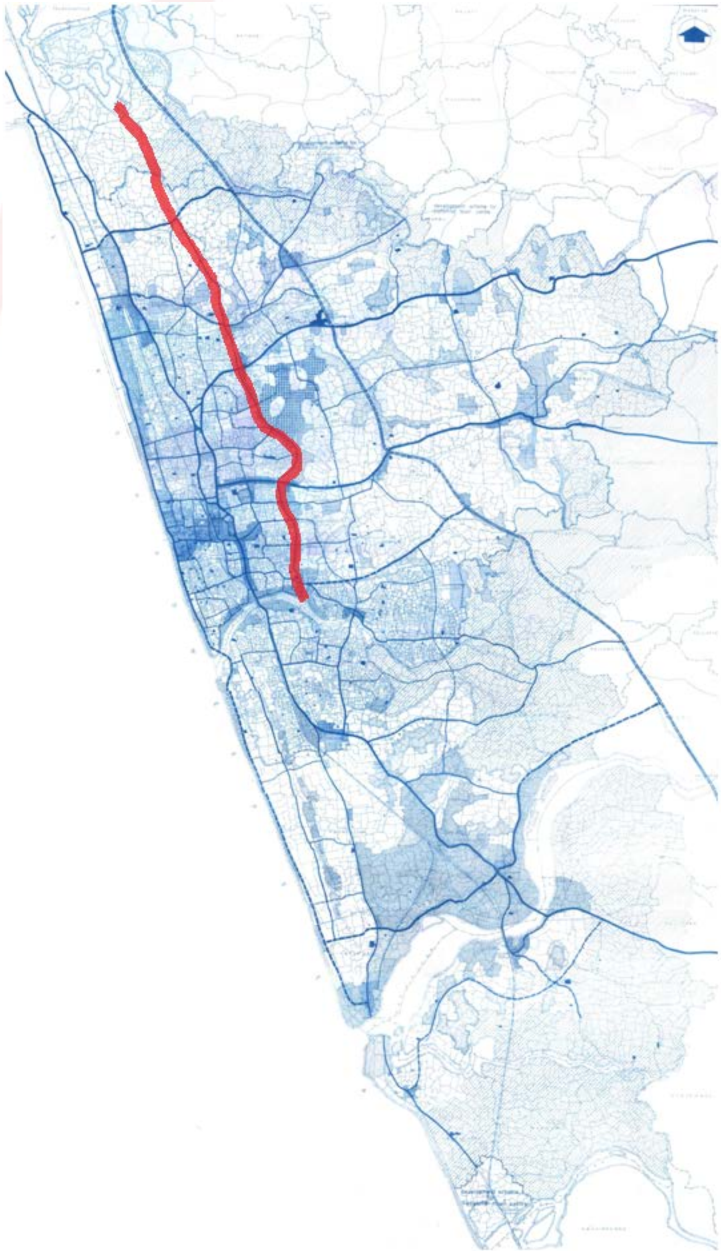

Figure 3. Canoly Canal in Kozhikode Corporation Limits

WETLANDS

Kottuli Wetlands

Kottuli wetland is one of the largest eco- patches within the city limits. It is interlinked with Canoly canal which receives tidal influx from the estuary of river Kallayi. The wetland covering an area of 87.04 hectares is rich in species of mangroves and mangrove associates. It is reported to be rich in aquatic organisms and bird species. This wetland has been identified by the Ministry of Environment and Forests, Government of India, under National Wetland Conservation Programme. It is one of the 115 wetlands identified as on June 26, 2009 by the programme (Government of India, 2009).

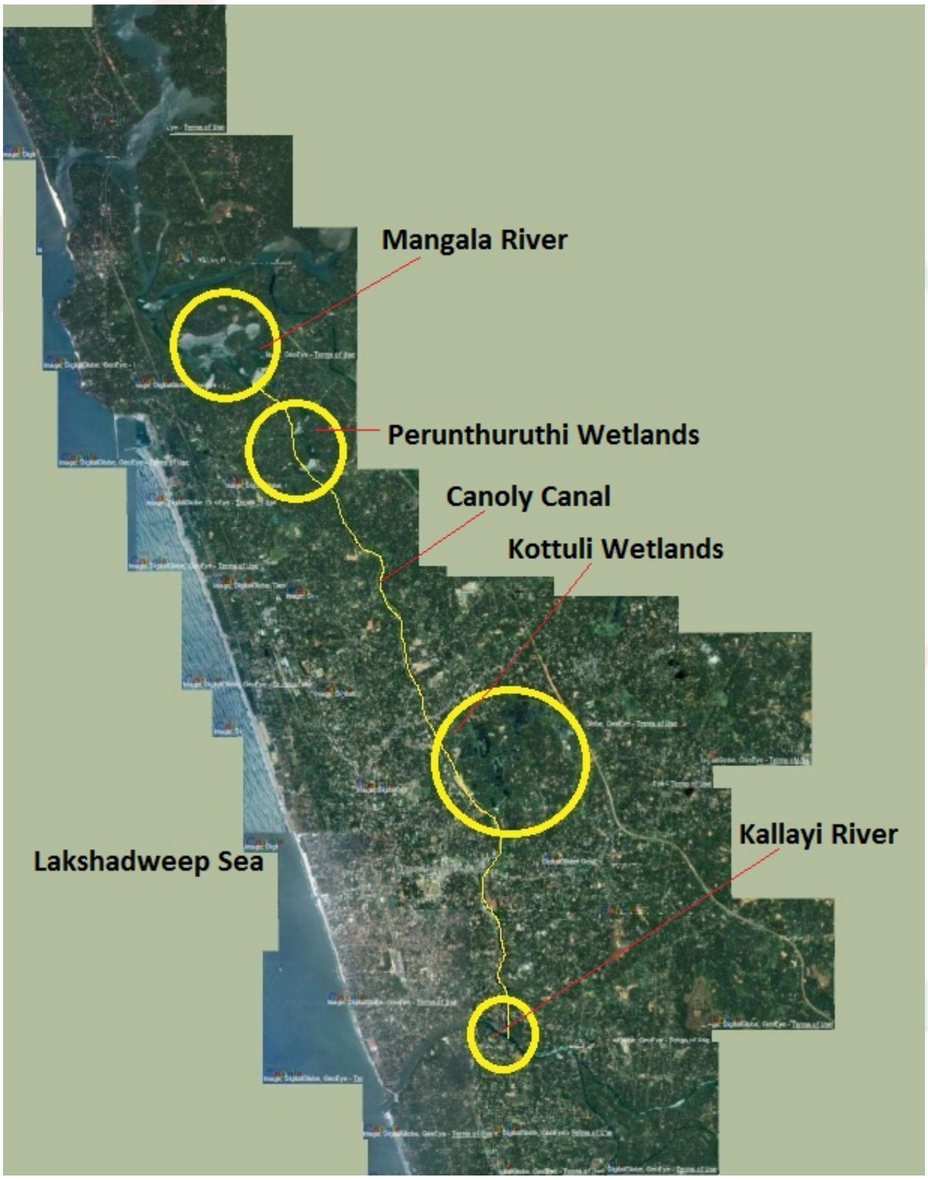

Figure 4a. Canoly Canal and wetlands location – Google satellite imagery

Perunthuruthi Wetlands

The Perunthuruthi Wetlands cover an area of about 60 hectares, in two parts. The northern part is called Mangala River, though morphologically it is part of the estuary of Korappuzha. It receives tidal influx from Korappuzha River. The second part has no surface connection to Mangala River. It is located further south and east of Mangala river estuary. It experiences tidal influx and salinity consequently through the Canoly Canal. The area is under aquaculture.

OBJECTIVE OF THE STUDY

Canals meant for navigation, more often than not, connect distinct watersheds, and rely upon wetlands to sustain water levels required for navigation. Interventions meant for the canals are undertaken without considering the qualitative and quantitative impacts on the wetlands they are connected to. The Kerala Shipping and Inland Navigation Department's proposal to revive the West Coast Canal System includes the deepening and widening of Canoly Canal. The National Bank for Agriculture and Rural Development (NABARD) is assisting the project to de-silt the Canoly canal and Kallayi River. The proposal to deepen Kallayi River to ensure flow from the canal to the river is funded by the River Management Fund. The objective of the project is to improve drainage in the city.

This study addresses the impacts on hydrodynamics in Kottuli wetlands by the proposed deepening of Canoly Canal. A similar study undertaken on Mangala river and Perunthuruthi wetlands will help draw up development plans for land use and inland navigation that take into account the impacts on the wetlands.

LIMITATIONS

The study concerns itself only with the flow patterns deduced from topographical analysis and field observations. Qualitative aspects like pollution and salinity intrusion have not been dealt with here, but have been covered in other studies (Hamno and Pettersson, 2005). Quantitative aspects of the flow dynamics is a further area of study.

TOPOGRAPHY

The Canal is oriented to direct inflow from 4 water bodies:

1. Mangala River
2. Perunthuruthi Wetlands
3. Kottuli Wetlands
4. Kallayi River

The highest elevation is found at Kunduparamba and lowest at Kottuli. (see Fig. 3) The red line shows the alignment of the canal and the dark ones are 5m contour lines. The blue areas represent water bodies.

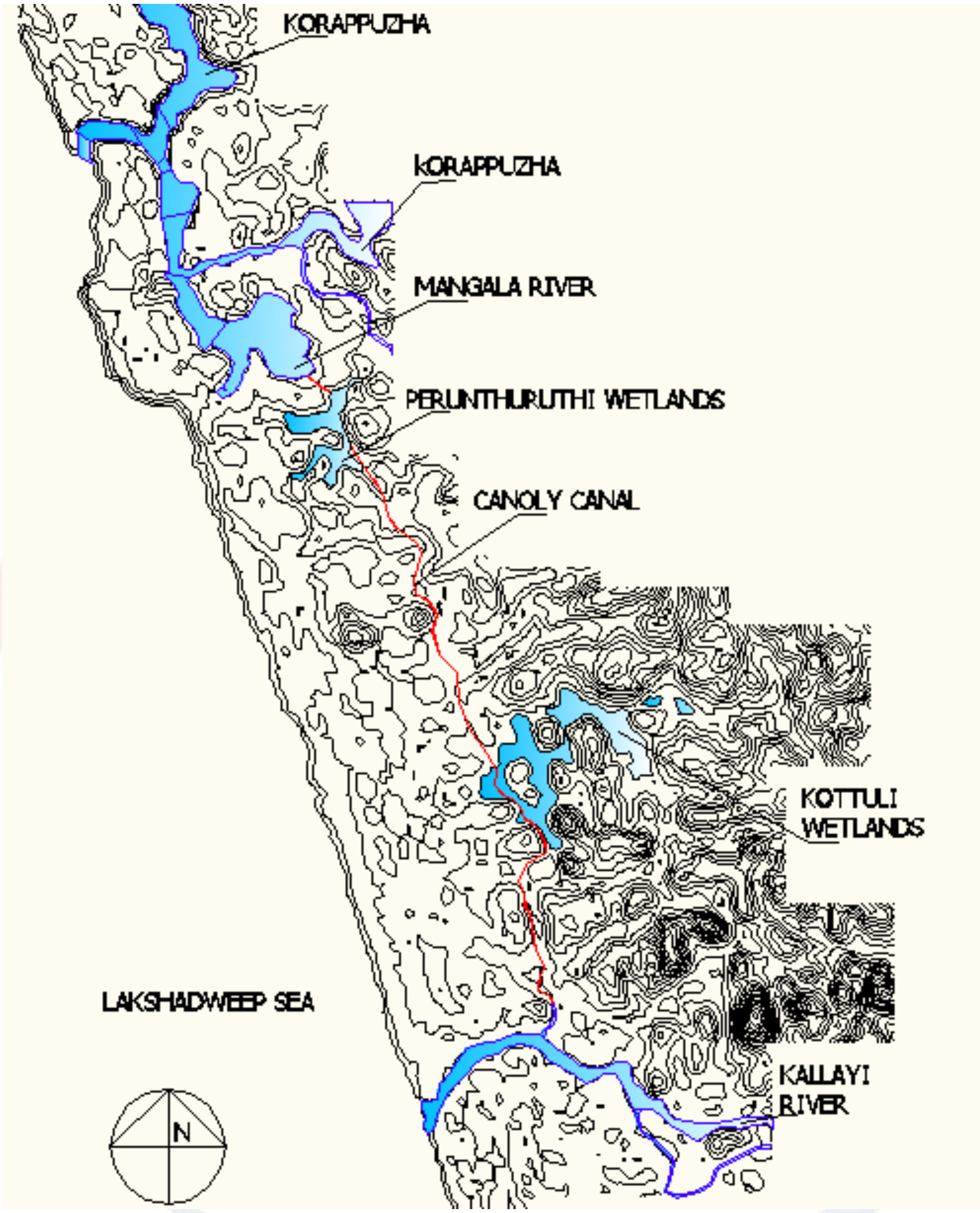

Figure 4b. Topography of canal environs

HYDROLOGY

Surface Water Hydrology

Analysis of the topography of the region shows that the stretch of the canal from Elathur to Kunduparamba falls in the Mangala river basin, and the rest, from Kunduparamba to Kallayi, falls in the Kallayippuzha (Kallayi river) basin. The canal passes through the ridge between the two basins between Puthiyangadi and Kunduparamba; this is also the point that has maximum depth of the canal, minimum water depth and minimum tidal fluctuations.

Tidal influx into the Canal is experienced for a distance of 3km into the canal from both ends, from Mangala River and Kallayi River (Hamno and Pettersson, 2005).Other than secondary tributaries of Kallayi river, it is the two wetlands – Kottuli and Perunthuruthi, that maintain the water level in the canal in the mid sections(Anjana, AKK and Deepak, 2013). Fresh water from the wetlands flows into the canal and into the Kallayi estuary and reaches the sea. The quantum of this outflow needs to be determined to estimate the extent of fresh surface water loss involved.

Ground Water Hydrology

Kozhikode district is underlain by a shallow unconfined sandy aquifer with thickness varying from 4m to 12m (Bazak and Nazimuddin, 1983). The depth to the groundwater varies over the year from 0.21 m and 4.5 (Bazak and Nazimuddin, 1988). The least depth (to groundwater) is during the monsoon period, June to November, when the recharge is large. The areas to the west of Kottuli wetlands, beyond the Mini Bypass Road which are presently under residential land use, are flooded during the monsoons (The Hindu, June 13, 2010; November 1, 2008).

The depth of the canal ranges from 3.8m to 11m, (Hamno and Pettersson, 2005). Ground water seeps into the canal in varying quantities through the length of the canal depending on the water table depth at individual locations. The flow is assumed to be the maximum at Kottuli wetlands and Perunthuruthi wetlands where the water table is at its highest (0.21m during monsoon months). The quantum of outflow of groundwater into the canal, the estuaries and eventually to the sea can be measured to quantify aquifer depletion with accuracy.

KOTTULI WETLANDS-MODELLED FLOW PATTERN IN 1848

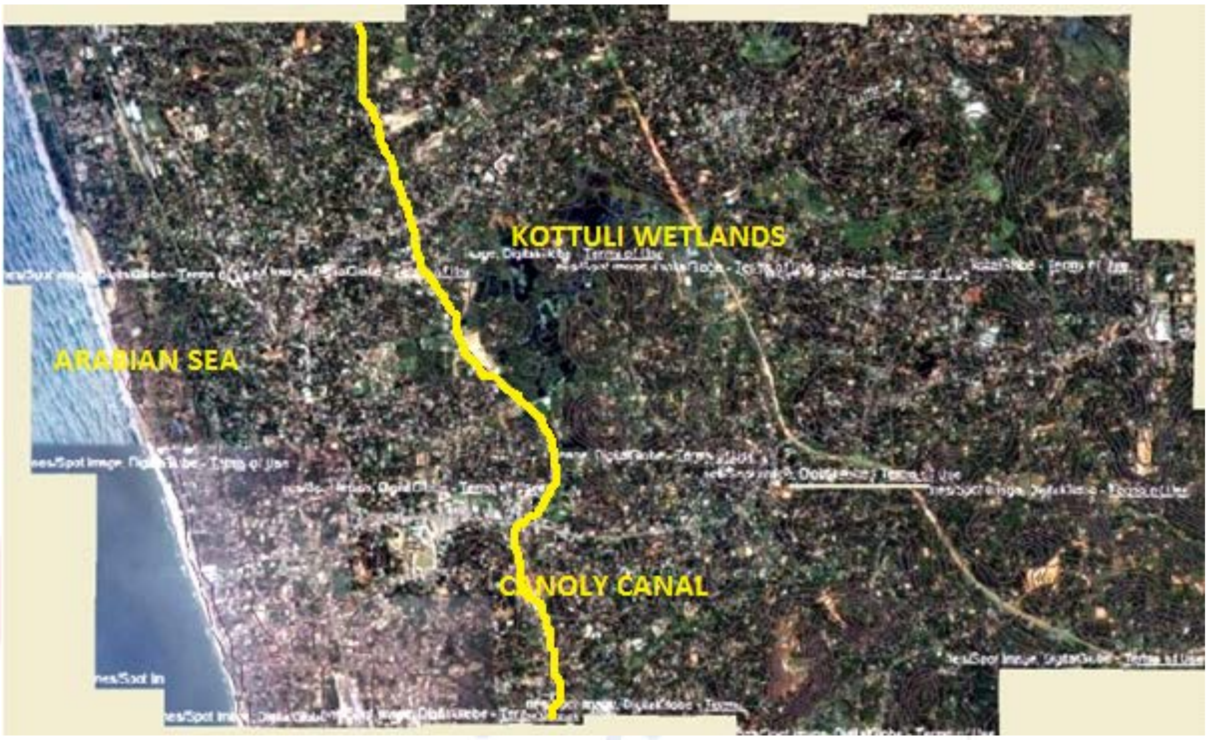

Figure 5 . Kottuli wetlands area; Google satellite imagery

The above figure illustrates how the Canoly /canal is oriented to direct the ground and surface water from Kottuli wetlands into the canal. A topographical map of the region with a contour interval of 2m was prepared based on the elevation information from Google Earth. The flow pattern of the region discounting the canal was analysed using Arcmap. The pattern shows a generalised flow towards the west, the Arabian Sea. Once the canal was built in 1848, the surface water and ground water was directed to the canal to maintain the water level for navigational purposes. Water from the canal flowed into the Kallayi river in the south and subsequently into the sea. This channelisation of outflow led to rapid loss of water into the sea both directly as above and indirectly by cutting off sheet flow towards the west. This results in loss of water extent and ground water recharge.

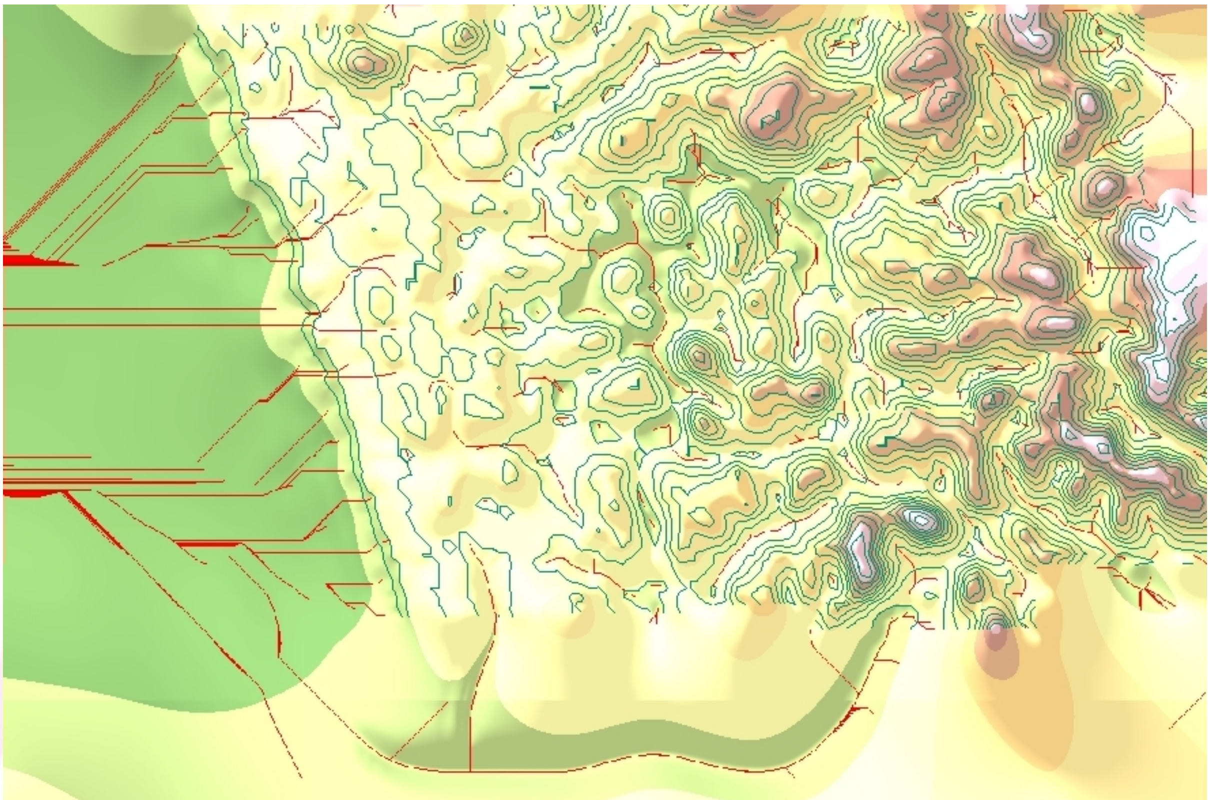

Figure 6. Flow pattern discounting the canal

KOTTULI WETLANDS – MODELLED SURFACE WATER COVERAGES

Viewed in isolation, the Canoly Canal and Kallayi River deepening project, aiming to improve the infrastructure and transport in the city, appear to have no negative externalities. But, the Canoly Canal connects the basins of Kallayippuzha and Korappuzha. This interconnectedness demands inspection of the water dynamics in an integrated fashion and points to a significant potential depletion of the wetlands. The methodology and results of this impact are discussed in this and following sections.

The present move by the Kerala Shipping and Inland Navigation Department and the Irrigation and Drainage Department to deepen the Kallayi River and Canoly canal can increase the outflow into the canal – both surface and ground water – thereby changing the seasonal pattern of water level which is the signature of the wetlands. The ground water flow into the canal will be through approximately 1300 sq m in Kottuli wetlands and 1080 Sq m in Perunthuruthi wetlands, assuming a deepening of 2m. Although the drainage through large tracts of wetlands points to a large quantity of water loss, its quantification is conspicuous by its absence.

The message of 'The Economics of Ecosystems and Biodiversity for Wetland' report commissioned by the Ramsar convention is, 'drain it, lose it'. A fall in water level in the wetlands can change the ecosystem. Flora and fauna dependent on depth and extent of water and valuable ecosystem services like ground water recharge, flood mitigation, nutrient recycling will be disturbed, not to mention resource for sustainable tourism and recreation.

The flow of water into the canal from the sea is at the two mouths during high tides. Fig. 5 (reproduced from Hamno and Pettersson, 2005) shows that the inflow into the canal is about 1/7th of the outflow. Given that there was rainfall in the region the day before the study was conducted (Hamno and Petterson, 2005), this variance is still significant. The outflow from the canal is more through the Kallayippuzha mouth. This could be explained by 2 factors:

1. The flow of water from the Kottuli wetlands and secondary tributaries of Kallayi River into the canal
2. Ground water flow into the canal through the entire length of the canal

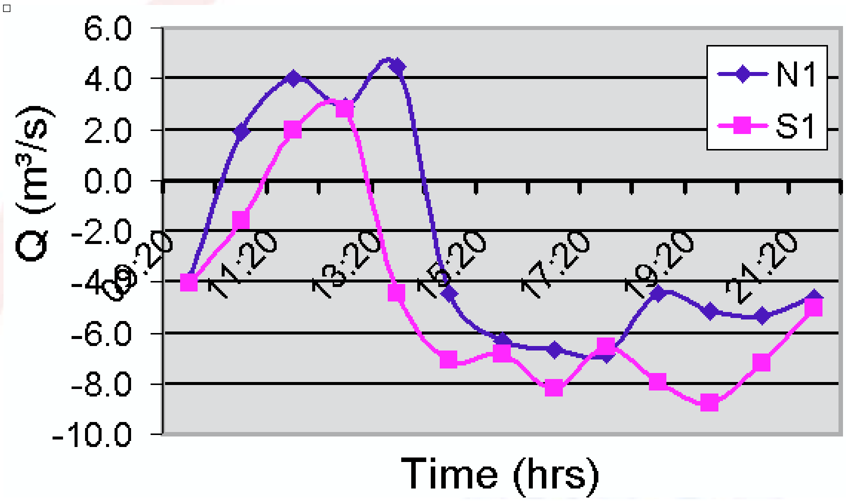

Figure 7. Flow in and out at both mouths (N1, S1) of canal

Sizing Methodology and Results

A topographical map with 2m contour intervals was prepared for the region, using spot levels from Google satellite imagery of 2007. The extent of water now (2007) was mapped with imagery and field observations (see Fig 6b). The depth of the canal at Kottuli proposed to be deepened by 2m from the current 8.4m (Hamno and Pettersson, 2005), the surface water level would also fall by 2m causing a shrinkage of the wetland area (see Fig 6c). Fig 6a is the reconstructed extent of Kottuli wetlands before the Canoly canal was built in 1848. The present depth of the canal bottom at Kottuli area is 8.4m (Hamnos and Pettersson, 2005). The reconstruction takes a decrease in water level equal to half the depth of excavation involved (that is, 4.2m). This, in our view, is the least that the Wetlands might have extended to back in 1848.

The next major event in the history of the wetlands is the construction of the Mini Bypass road and Bypass Roads both of which caused further fragmentation of the wetlands. Fragmentation of water surface water makes the filling process easier, therefore accelerating its pace. This analysis shows the strong depletion of the wetlands by the canal and its deepening (see Fig 8, 9 and10). This shrinkage is caused by the direct consequence of surface water level dropping (land 'reclamation') and accelerated by the subsequent fragmentation of the wetlands (making way for roads, residential and commercial developments).

9. CONCLUSION

The height of water table, precipitation, runoff, evaporation and the flow into the canal are the major factors in the hydrodynamics of Kottuli wetlands. This hydrodynamic is the most important determinant for the establishment and maintenance of specific types of wetlands and wetland processes (Mitsch and Gosselink, 2007). This balance needs to be understood and impacts on each of the systems – rivers, canal and wetlands – analyzed before interventions, which could potentially change the hydrodynamics.

If the Canoly canal is deepened, the outflow from the surface and the aquifer at Kottuli wetlands into the canal will increase, leading to a reduction in the area of wetlands. The degree of fragmentation will also increase owing to the topography of the region. This study brings to light the effect of Canals on wetland systems. This would assist planners in making informed and carefully calibrated decisions in the spheres of wetland conservation, canal development and land use allocation.

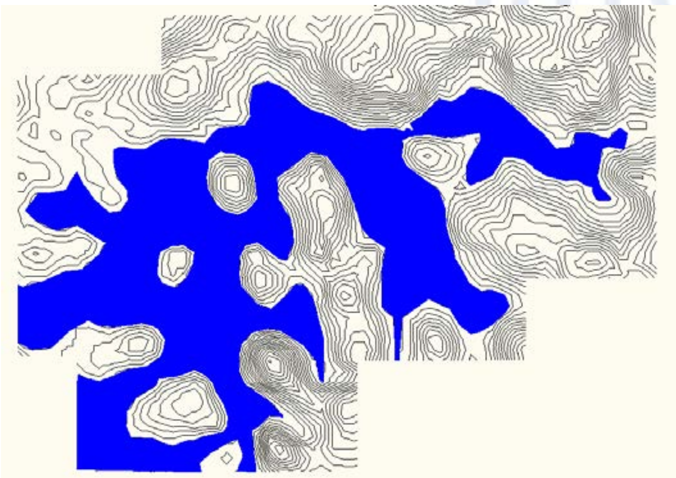

Figure 8. Hypothesized extent of Kottuli wetlands before Canoly Canal based on topography

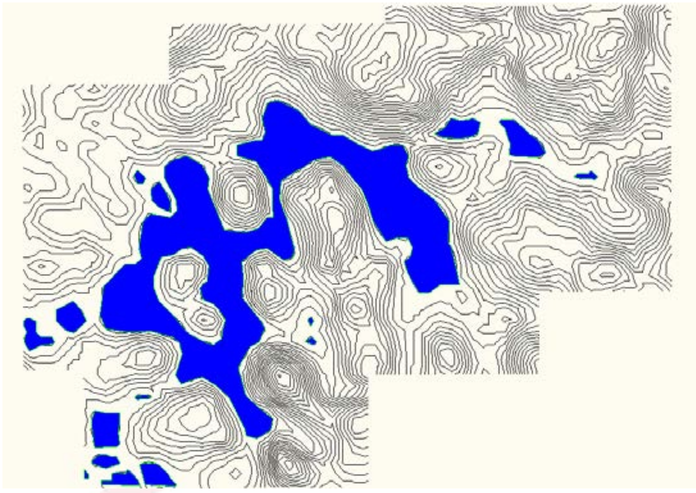

Figure 9. Present (2007) extent of wetlands based on topography

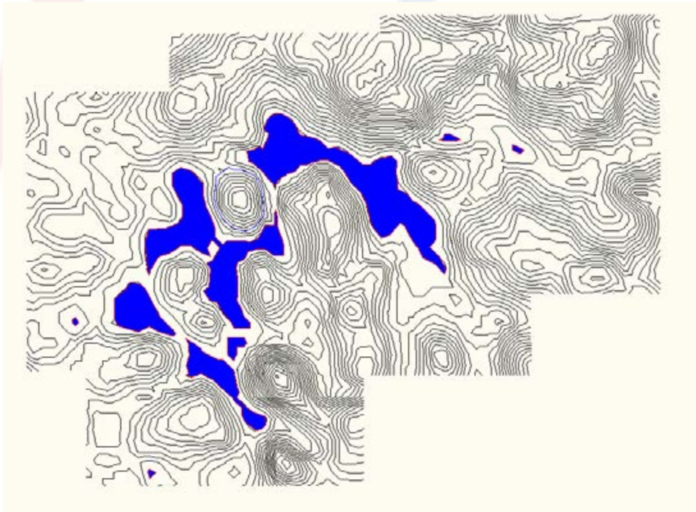

Figure 10. Extent of Kottuli wetlands assuming a deepening of 2m in the canal

10. RECOMMENDATIONS

If the watersheds approach to surface water management is undertaken for the city, such inconsistencies can be ironed out. The interconnected nature of river systems means that successful water management requires the adoption of methodologies which consider all bodies of water within a basin as opposed to just one body in a system. Depending on the flow dynamics, any alteration in one body can have implications in the system as a whole or parts. The river basin provides the natural unit for such an approach.

The basins needs to be demarcated and the flow pattern identified. The first step in the direction is the preparation of topographical map of the region with a contour interval of at least 2m. This will have uses in other spheres of urban management too, like the designing of water supply and sewerage system, transport network, water harvesting, irrigation network and delineating boundaries of natural resources for conservation efforts and planning.

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