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The role of waterways in promoting urban resilience: The case of Kochi City

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Working Paper No. 359

**The Role of Waterways in Promoting
Urban Resilience: The Case of Kochi City**

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Sandeep Paul**

May 2018



INDIAN COUNCIL FOR RESEARCH ON INTERNATIONAL ECONOMIC RELATIONS

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Abstract

Coastal cities around the world are locales of high vulnerability. The issues are graver in the developing world where the challenges posed by the urbanisation and climate change multiply the existing risks. Here, we examine the case of Kochi, an Indian city located at the centre of a rapidly urbanizing coastal and estuarine region. In Kochi, a port city characterised by crisscrossing canals and rivers connected to a backwater system, waterways used to play a major role in the socio-economic and cultural development of the region. They not only supported the commerce and economy but also connected communities, supported a rich and diverse ecosystem and provided livelihood opportunities. However, poor planning and management of the industrialization and urbanization processes resulted in the neglect and widespread exploitation of this resource over the years, undermining its ability to support both ecology and connectivity. In the recent years, partly due to growing recognition of climate change, and need for both mitigation and adaptation, there has been a renewed interest in investing in waterways to enhance connectivity in the region. The study examines how water ways can promote the climate, social and economic resilience of the city. It also critically compares these efforts against the global experiences and attempts to identify multiple limitations and challenges to development of water ways in Kochi. The global experiences could be useful for Kochi as it is now starting to focus on waterways development as a crucial part of its integrated transportation network.

Keywords: *Inland waterways, Resilience, Kochi, Climate change*

JEL Classification: *R40, R42, R58, Q25*

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The Role of Waterways in Promoting Urban Resilience: The Case of Kochi City

Zeba Aziz, Indro Ray, Sandeep Paul

1. Introduction

The battle on climate change is increasingly becoming local. As climate policy is shifting away from its centralised, top down approaches, climate action is increasingly shifting to the cities – the nodes of economic growth. The consensus is that sub-national governments have a crucial role to play especially in adaptation as they have better knowledge of locale specific vulnerabilities and are better placed to bring together civil society and communities for collective action. As per the IPCC fifth assessment report (IPCC,2014) *“In urban areas climate change is projected to increase risks for people, assets, economies and ecosystems, including risks from heat stress, storms and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, sea level rise and storm surges (very high confidence). These risks are amplified for those lacking essential infrastructure and services or living in exposed areas”*.

This is particularly true of cities in the developing world, which are highly inequitable in terms of access to resources and service coverage, densely populated and lack even basic urban infrastructure. The development of most of these cities has been haphazard with little planning, severely endangering the ecosystems they are placed in. In this respect, it is important to understand the resilience of these cities to the risks arising out of climate change. The issue is more serious in coastal/riverine cities that are often more vulnerable to climate change than others. The fact that till recently, there was very little attention to urban water bodies and wetlands exasperates the problem. For example In India the approach to urban planning has been land centric with very little acknowledgement for water bodies or wetlands. Shah (2016) has noted that there is no specific legislation in India to protect water bodies. The laws in place like Wetlands (Conservation and Management) Rules, 2010 has left out most of the urban water bodies, causing the cities to grow over the water bodies and its functional parts (shah, 2016). It is in this background that we explore the role of waterways in the resilience paradigm of an urban space- city of Kochi in this case.

2. Kochi

Coastal cities around the world have played a pivotal role in the history of civilisation, as centres of global trade and commerce, of cultural exchanges, of vibrant local economies and of rapid growth and transformation. Like many of its counterparts around the world, the city of Kochi, located along India’s Western coast, enjoys a strategic location, and has always been sought-after by nations looking to dominate in the area. Through the numerous waves of colonisation (the Portuguese in the sixteenth century, the Dutch and the British in the nineteenth century), the city flourished as a port, gaining in both economic prowess and population. The port city, Fort Kochi, became a municipality during this period, responding to the need for planning and governance in the growing city.

Today, with a population of over 600,000, Kochi is the largest city in the south Indian state of Kerala and the second largest along India's western coastline, after Mumbai. The city has extended from the erstwhile Fort Kochi to areas in the east, including Mattancherry and Ernakulam. It is part of a rapidly growing contiguous urban region comprising seven other cities and forty-five census towns, and a population that has doubled in the past decade to two million, making it one of the fastest growing urban hubs in the country (GOI, 2011).

In addition to being the most populated city in the state, Kochi is also the regional economic hub. Ernakulam district, within which the city lies, is the largest contributor to the state's gross domestic product and has the highest share of industrial units in the state.¹ More recently, Kochi has seen an increase in investment in the electronics/IT related industry with several IT parks and specialised SEZs setting up in the city. Port activities also continue to remain central to the region's economy, with Kochi port being one of the 12 major ports in the country. Tea/coffee, coir, cashew kernels and seafood are some of the region's key exports. Given the local heritage and the region's natural setting along the backwaters, Kochi is also a key tourist attraction, which is a major contributor to the city's economy, generating both income and employment.

As with other rapidly growing cities and urban regions in the country, Kochi struggles to balance the demands of the growing population and economy with the need to safeguard resources. Issues such as unchecked development, congestion on roads, pollution of air and water resources and gaps in city services are rampant, putting a strain on the limited capacity and resources of the local government. And for Kochi, a coastal city with more than 80 percent area within 5 metres of the mean sea level, there is yet another aspect to consider alongside others. In the context of changing climate and its associated effects such as sea level rise, increased precipitation and flooding, this coastal city must seek to reduce these risks and safeguard its competitiveness. Coastal and riverine cities across Asia and the world face similar threats. Recent flood events across Bangladesh, Philippines, Malaysia, or coastal cities in the USA such as New York or New Orleans illustrate the vulnerability of such cities and the scale of potential setbacks. Entire cities and local economies come to a standstill for long periods due to disruptions caused by these events, not to mention the direct losses to life and property.

In Kochi's case, thanks to its location on the lower west coast of the Indian peninsula, it is less vulnerable to storm surges or cyclones compared to cities on the eastern coast of the country (Shaji, Kar & Vishal, 2014).² Despite this relative advantage, changing weather systems across the world mean that Kochi will continue to remain vulnerable to flooding, either through extreme precipitation events or through a gradual rise in the sea level (Kumar, 2006).

¹ Kochi Development Plan: Medium - Large Scale Industrial Units registered in Kerala, March, 2007 – Kerala State Industrial Development Corporation (KSIDC, Thiruvananthapuram)

² The number of cyclones occurring in the Bay of Bengal is about four times higher than that in the Arabian Sea. This is in part due to the wind patterns; Arabian Sea cyclones move either west to north-west or due north and then east.

The city sits within a complex estuarine system comprising Lake Vembanad and the many rivers flowing into the lake, including the Periyar and Muvattupuzha rivers. This water sheet, consisting of canals, backwaters, rivers, etc., accounts for a sizable proportion of the land. The water system and its ecology is critical for the city's natural drainage, flood protection and protection from storm surges (mangroves) and also to its traditional local economy that depends on its resources (e.g., fishing and coir industry).³

Figure 1: Map showing the setting of Kochi city within the context of Vembanad Lake



Source: Authors

In addition to flood protection, these naturally existing water channels in the city can also provide, as in other cities around the world like Venice and Amsterdam, an alternate avenue for intra and inter-city transport. Such alternate systems help add a layer of redundancy to connectivity within the city and safeguard accessibility between people and resources. It is in this respect that the development of waterways can become an excellent opportunity to improve climate resilience. In addition waterway systems can offer multiple co-benefits. Water transport systems incur lower costs of development, management and maintenance as compared to road systems. Estimates indicate that the cost of establishing inland waterways are only 5-10 per cent that of 4-lane highways, while the maintenance cost is roughly 20 per

³ 'The wide variety of fish and shellfish resources, aquaculture systems, the brackish water agriculture, mangroves and innumerable forms of micro-organisms are directly useful and sustain the economy of the local population. The brackish water body benefits the coir industry of Kerala as rural communities use Kayals and the nearby wetlands for soaking coconut husks' (Thomson, 2002).

cent (Sriraman, 2010). These are significant savings for under-resourced cities in India. The development of climate proof waterways infrastructure including replacing or modifying jetties and docks may also contribute towards development of bank protection structures, management of water levels, weed growth, siltation etc., and restoration of natural drainage through the revival of canals and small rivers. It should be also noted that the development of such a system is critical not only from an adaptation point of view but also for mitigating climate change. The per capita energy consumption in water transport tends to be lower than that of surface transport and it can contribute to efforts to reduce carbon emissions. Even by conservative estimates, implementation of ferry services in just five major routes in Kochi can lead to net emission savings to the tune of 7500 tonnes of CO₂ annually (CDIA, 2010). As infrastructure in the water transport sector is not yet well developed, there is potential in this area for faster integration of environment friendly technology at a relatively low cost.

In Kochi's case however, due to the pressures of development, unplanned growth and lag in services, the percentage share of area under water systems, which was as high as 23.4 per cent in 1981, has been declining over time (GoK, 2010 a). Many of the inner city canals have become victims of encroachment and neglect through silting, reclamation, fly tipping and disposal of untreated sewage and industrial effluents, making them unsuitable for navigational purposes and incapable of offering flood protection or supporting water ecosystems and the economies dependent on it. Significant investment will be required for the initial clearing of these water channels and dredging them to a navigable depth of minimum 2m⁴ and for their regular upkeep. Currently, the corporation spends an average of Rs. 10 crore every year for de-silting the canals and rivulets before the monsoon (Kumar, 2017). Despite this, less than four per cent of the approximately 1,000 km of waterways in the region are navigable (IWAI). Investment in and emphasis on improvement of solid and liquid waste management in the city are also needed to ensure that the channels are kept clear.

In this context, it is imperative to consider how Kochi can leverage its access to waterways to improve its resilience, given the current status of the water systems and channels. Transportation is only one of the ways waterways contribute to the city. They also play a key role in the regions ecology and biodiversity, flood protection and its local economies, especially tourism. Safeguarding the waterways from urban impacts is thus key to ensure they continue to safeguard our cities and regions in return from the impacts of a changing climate. The next section looks at some of the measures taken by countries in Europe to rejuvenate waterways that could provide lessons for Kochi.

3. Global best practices for waterways development

Inland waterways have been a tool for navigation and transporting goods across the world for centuries. But with time, they have also been seen as an integral element for delivering regional development and building climate resilience. Thus, the role of waterways has moved beyond freight and people transport and now includes being hubs of multi-modal transport

⁴ Inland Waterways Authority of India (IWAI) regulations

connectivity, job creation, housing and real estate opportunities, and tourism. To study and understand how these roles have manifested in different locations and to draw lessons from them, this study focuses on some European countries. The choice of examples and case studies are limited to Europe because most of its countries are criss-crossed by several large and small rivers and man-made canals and over time, they have pioneered waterways development. They are also some of the best global examples to follow for countries, regions and cities with similar attributes. In this case, Kochi can learn a great deal from such examples. As discussed above, the city of Kochi has mostly considered and utilised its waterways as part of its network for storm water drainage and dumping wastewater; water navigation so far has remained underutilised. Years of such practice has resulted in high pollution of backwaters while siltation has reduced the navigability of these waterways.

In this context, European case studies are discussed while highlighting how different local governments looked beyond their existing roles and responsibilities to develop their respective waterways (rivers and canals). To understand and evaluate each of the specific waterway development efforts and how they were used to meet certain social, economic, and environmental criteria, the following discussion is divided under two heads – a) governance and b) environment and climate change. The first topic mainly covers the overall vision, stakeholders, problems and opportunities faced in the planning and implementation process. The second head covers key actions, funding, and good practices (Waterways Forward, 2012 a).

The broader topic of governance of waterways covers the development agenda where waterways are seen as a source of income that boosts the local economy and creates jobs while promoting business opportunities along waterways. The economic vantage point to develop waterways have been captured in many of the development plans through the broader topics of tourism, water freight movement, and adaptation for climate change (ibid). Here, economic activities like tourism and freight movement are included as it is argued that having an economic vision for waterways can help meet sustainable development objectives. But it has to be noted that in all cases, the economic agenda has been promoted while highlighting the environmental benefits (through lower emissions, ecological protection, and increased public awareness about environment) of such activities.

Tourism is one of the major activities around which the development of waterways has taken place in several countries in Europe. In most countries, tourism is the ‘go to’ option for bringing economic development to a specific regions endowed with waterways. The examples below showcases how this theme has been developed while taking into account comprehensive restoration and development of the waterways themselves.

In Spain, the town of Melgar de Fernamental capitalised on the economic aspects of tourism with the larger plan to recover the hydrological and environmental aspects of the Castilla channel. This was followed by developing various inventories along the channel, renovation of old homes, barns, and warehouses, and the restoration of landmarks and surrounding environment. The infrastructure built during the channel restoration project was then used by private enterprises to be part of economic rejuvenation through tourism. Thus, waterway

development and developing tourist attractions and pit stops along it lead to sustainability and profitability of economic activities in the area (Waterways Forward, 2012 b).

Along Italy's Navigli waterways in the Lombardi region, tourism was developed by restoring the waterways and the historic sites around it. A detailed tourism itinerary was developed that included details like time required for completing the trip, level of accessibility to the sites, and places to visit and eat at. Some promotional plans were also carried out. Five tourism lines/packages were developed and each was based around different themes. These integrated tourist packages were created by involving public and private stakeholders. To create business and employment opportunities, stakeholders were encouraged to undertake projects in sectors like infrastructure and services that indirectly helped local tourism. These activities were financed by public funds. Thus, for Lombardi region, tourism was the means to bring together the significance of the canal and the historic sites around it and this integration of the waterways and landmarks around it was the main idea behind creating the tourism itinerary. These measures created jobs, rejuvenated the local economy while restoring the waterways (Waterways Forward, 2012 b).

In Poland where the Odra River was revived through making it multi functional, the key factors of success were creating a tourism profile of the river and its adjoining areas. The local government also made the whole process socially inclusive through cultural, sporting, and social events organised along the river. These steps not only revived the river and brought back tourism to the areas, but also ensured the renovation of many historic buildings.

In France, the government relied on mapping out long term goals to rejuvenate the Sambre corridor and attract investment. The maps were used as a tool in the decision making process. They also provided the vision of the government with respect to the development potential of the water corridor (Waterways Forward, 2012 b).

The other avenue that cities/nation states have chosen to revive and bring in investment to develop waterways is through freight transport. In Sweden, this was done by encouraging and investing in water freight movement in and around Lake Vanern area, where most of the freight movement was earlier dominated by road transport. To encourage freight movement through waterways and incorporate unitised freight, the port and freight terminals in the lake were modified by introducing IT based logistical systems, which also lead to higher efficiency. The unitised freight was achieved by developing/modifying containers and trailers that could be easily transferred between different modes of transport. The objective was to capture the potential for linking sea and river freight. During the whole process, the administration also took into account the effects of the development of water freight movement on the environment. All stakeholders were involved in the development process, right from the preparatory stage to build trust between public and private entities (Waterways Forward, 2012 b).

Finland, while wanting to utilise its waterways for freight, faced different kinds of issues. Its problems were regarding jurisdiction and political boundaries. The Saimaa Canal flows between Finland and Russia, but officially falls within the Russian national boundary. To

circumvent this problem, Finland leased the canal from Russia on a long term (50 years) basis with a revenue sharing agreement. The rental obligation includes building the canal, maintaining operations and up keep of the entire structure and the system. The fee or the rent paid to the Russian government is based on the freight traffic volume (tonnes). The agreement works for both the parties involved since development and better use of canal, and easier movement of freight leads to lower freight cost, and an increase in demand for water freight transport. Efficient utilisation of waterways for freight has led to more investment in the region (Waterways Forward, 2012 b)

In regional and local development documents, plans and actions for developing waterways are covered under various themes. Above we discussed the vision of developing waterways in different communities through the lens of governance. When it comes to translating the vision to actions and program implementation, it is mostly discussed under the heads of environment and climate change. Within this framework, cities can undertake either of two approaches. The first focuses on nature conservation and environmental protection with profit making as a secondary objective. Here actions are mainly taken towards improving water management, water quality, and ecological protection. Some of these actions will manifest in the form of developing flood control mechanisms like building retaining walls and controlling alien invasive species. The second sees the development of inland waterways as a means to boost the local economy and maximise benefits. Under this, navigation and recreation purposes are not seen as ecologically damaging and environmental benefits like reduction in CO₂ emission, and promotion of inland waterways as natural, cultural areas are seen as an additional takeaway (Waterways Forward, 2012 a).

The second heading under which waterways are revitalised and which also brought government and people together is environment and climate change adaptation. Among the European case studies, Ireland and Netherlands use environmental protection and climate change as the theme to make their waterways better. In Ireland, the national government took it on itself to maintain its national bio-diversity along with the waterways. It has set up the 'Good Ecological Potential' framework and has taken proactive measures to achieve its objectives. While implementing the programme to achieve and maintain its ecological bio-diversity along its rivers and canals, a monitoring programme was set up along with developing a canal/waterways classification tool to assess the quality of waterways. The monitoring programme involved seasonal sampling of ecological quality elements like physio-chemical parameters, invertebrate fauna, macrophytes, and hydro morphology. Subsequently, based on the baseline data and historic data, canal classification is done. The monitoring tool and data parameters are also used to identify and select areas that are at risk and need immediate attention. Such a framework has resulted in a majority of the canals being classified as ones with good ecological potential. Another major outcome has been the improvement of overall water quality in the waterways, which is directly linked to their use as multi-purpose amenity resources (Waterways Forward, 2012 b).

In the Netherlands, it was more about making cities and communities along rivers and waterways safer and resilient to heavy water discharge from upstream or in case of high

precipitation. To accommodate high water flow and deal with high water levels, dikes were rebuilt to increase the room for future water flows in 39 strategic locations. This programme was named 'Room for the river' plan. While creating more room for the river, the objective was to provide more space for nature and recreation. The specific steps taken under the plan included lowering of floodplains for both the main river and its tributaries, and relocating dikes further in to the inlands; groyne were lowered in the rivers while deepening summer beds. This boosted the regional economy, improved its ecology and enhanced the scenic view (Waterways Forward, 2012 b).

4. Waterways for increased resilience

One of the sad realities of our times is that the natural endowments present around us are undervalued by government institutions and individuals. There are various reasons and factors behind this attitude towards natural features like forests, mountains, rivers, lakes and oceans. Some of them include our inability to see the long-term damage of our actions; we, as a society, are used to deriving benefits from them without taking care of them and thus, over time, we have come to take them for granted. Households and industries have been dumping untreated waste in the rivers, developers have been building on the path of natural drainage, deforestation has been rampant while pollution of our mountains and oceans has led to certain irreversible changes. Such behaviour has been detrimental to the roles these features (in this case, waterways) have played in their local and regional eco-systems. But over the last few decades, this neglect towards our waterways has come full circle, leading to risks that are directly linked to waterways. These risks and vulnerabilities include local floods, deteriorating water quality leading to health concerns for the general public and livelihood concern for fishermen; silting and indiscriminate dumping of waste has made our waterways un-navigable; due to high water pollution, the real estate value along the waterways has declined with many people abandoning such locations altogether. So, the challenges a city government faces when it does not take proactive measures to protect its waterway include social, environmental and economic risks.

Such risks and vulnerabilities have been faced by local governments across the globe, including in developed countries. In the previous section, while discussing some waterways case studies in Europe, we highlighted the methods adopted by public institutions in collaboration with private stakeholders to overcome such risks. They revitalised their waterways by building larger economic and environmental programmes around them. Some of the themes include tourism, freight transport, enhancing bio-diversity, and water management. These programmes have not only improved the quality of respective waterways, they have also increased the region's economic and climate resilience. So, a fast growing city like Kochi that reels under several vulnerabilities threatening its economic, social and climate resilience, can learn and adopt a great deal from such good practices.

As mentioned previously, Kochi is highly susceptible to the risks of climate change. There is high agreement that coastal systems in particular are highly sensitive to climate drivers (any climate-induced factor that directly or indirectly causes a change) like sea level, ocean temperature, and ocean acidity. The risks could be much higher in the case of coastal cities

that are often centres of high economic activity and urbanisation. As this trend is expected to continue, the risks to natural and human assets as well as human pressures on coastal ecosystems will increase significantly in coming decades (Wong et.al, 2014). The negative consequences of acidification and warming of coastal waters will further worsen the risk profile in these areas. For Kochi, the major expected threats are changes in the sea level, temperature and precipitation patterns (Murali & Kumar, 2015) (Kumar 2006) (ORNL & CUSAT, 2003). These effects could exacerbate existing vulnerabilities of the city. Unplanned development, indiscriminate discharge of wastes and effluents by industries, lack of scientific waste management (especially of solid wastes), the presence of low-lying islands, and scarcity of funds are all factors likely to worsen the outlook.

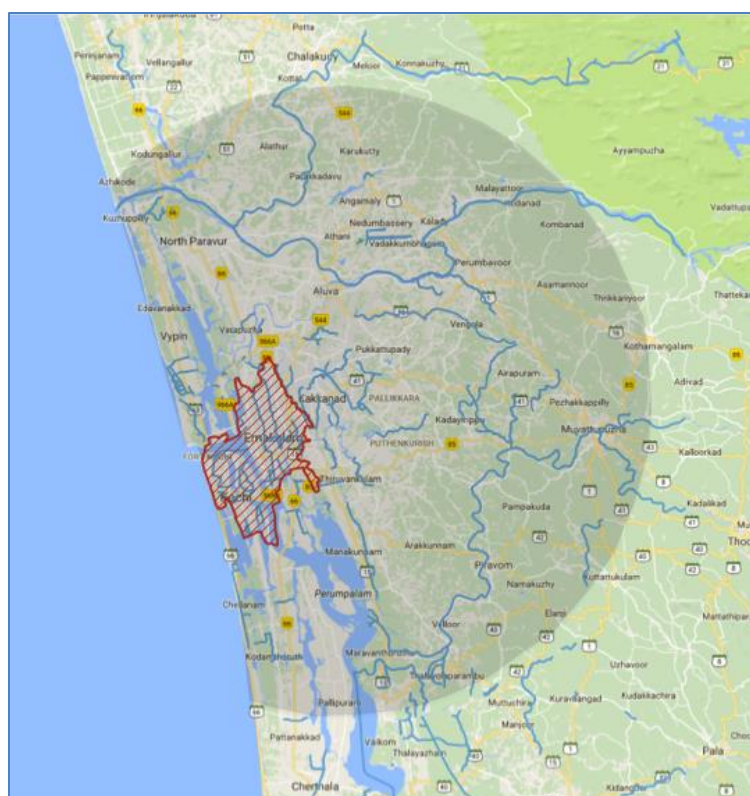
In this context, Kochi's waterways offer an opportunity for the city to adapt to the changing climatic conditions to safeguard its people, economy and resources. Learnings from global best practices like 'Room for the river' in Netherlands and the Good Ecological Potential framework from Ireland, provide some good examples. Innovative approaches like these can be modified to the local context to revive Kochi's waterways. As illustrated through these examples, restoration of waterways can offer multiple co-benefits ranging from the delivery of an alternate affordable and clean transport system, environmental regeneration, boost to tourism and regional micro-economies and enhancement of natural storm protection and flood drainage mechanisms.

For example, revitalisation of the waterways in Kochi could contribute towards strengthening the social resilience of the city. An efficient and integrated water transport system could provide an affordable public transport alternative to communities in the western islands, which are also some of the most economically vulnerable in the city, and provide them better access to economic opportunities, employment, health and social facilities. Revitalisation could also offer the marginalised communities based along the waterways an opportunity for economic growth through cottage industry or tourism. Rapid urbanisation in the area has led to destruction of traditional economic activities in the region like fishing, agriculture, aquaculture, coir making, clam fishing, lime shell collection and traditional ferry and transport services (Thomson, 2002). The traditional fishing community in the region is the most marginalised socio-economic group with more than 55 per cent living below the poverty line (KMC, 2006), with low educational attainment, a higher proportion of wage labour, lower levels of ownership of material assets and a high proportion of spending from household income on travel (CDIA, 2010). As illustrated in examples from cities in European countries such as Spain, France and Italy, reviving the heritage links and traditional practices along the waterways could offer these communities an opportunity to tap into the economic benefits of tourism. Steps could be taken to integrate and involve them in the decision-making processes and restore the cultural and architectural heritage in the older parts of these towns.

Development of a water-based transport system could also be crucial for an efficient disaster management system. Water logging, inundation and paralysis of surface transport are already very common in the city even with low-intensity precipitation. In addition to offering an

efficient, affordable and low-carbon mode of transportation in the city, a water-based system could help make accessibility in the city more resilient to climate shocks by adding another layer of redundancy to public provision of transport and safeguard connectivity and accessibility between people, resources and emergency services. In the next section we focus on the opportunity for waterways in the transport sector. We examine the travel characteristics of the region, the viability of waterways to alleviate travel demand and the current projects and programmes in this sector.

Kochi is the employment hub within the region with more than 50 per cent trips to the area for work purposes. The city attracts a floating population of workers from distances up to 25km.⁵ Figure 2 shows an approximate radius of where Kochi's workers come from.

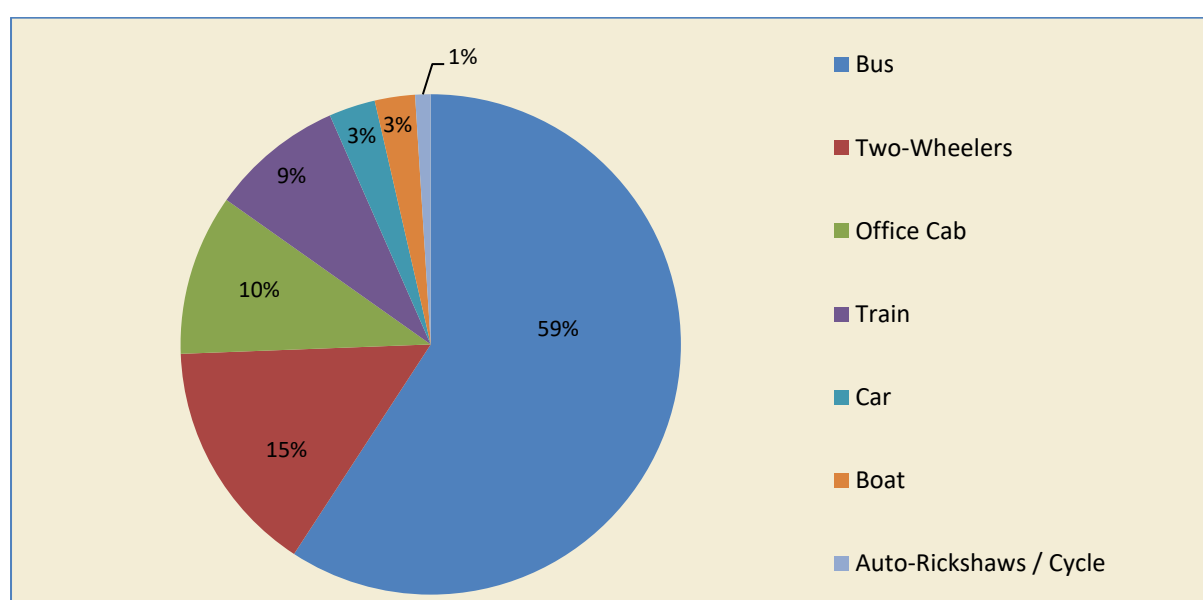


Source: Authors, Google Maps

⁵ Kochi's floating population is as high as 46 per cent of the resident population. According to the 69th round (2012) of the National Sample Survey, among major states, urban Kerala is second only to urban Maharashtra in the proportion of households for which the maximum distance travelled by any earner to reach the place of work was more than five kilometres,- Goswami et.al (2015)

the limited road capacity of most regional and city roads means that congestion and travel delays are common, leading to average travel times of over an hour. Most city roads have a right of way less than 5 m. In terms of carriage width, most city roads are either single lane (56.6 %) or less than single lane (16.3%) (NATPAC, 2006) (CPPR, 2016). A declining share of public transport in the recent past and rapid growth in private ownership of vehicles has heavily clogged the city. Kochi had registered a CAGR of 12.2 per cent in the number of registered vehicles between 2002 and 2012, which is the second highest growth rate among all the million plus cities in India (Transport Research Wing, 2013). Ernakulam district, to which Kochi belongs, has the highest number of motor vehicles with valid registrations in the state and adds the maximum number of vehicles every year (MVD, 2014).

Figure 3: Mode choice in commuting for work



Source: Adopted from Goswami et.al (2015)

In this context, Kochi's waterways present an alternative to release some of the pressure from the city's congested roadways. Kochi's western waterways form part of the 205-km West Coast Canal or National Waterway 3 that runs from Kollam to Kottapuram and is used for the movement of both passengers and goods. The waterways offer connectivity to not only different parts of the city but also to bedroom communities outside the metro. At present, the Kerala State Water Transport Department (KSWTD) is the key agency running passenger ferries, along with some private operators, mainly in the western part of the city, connecting the coastal areas and islands to the mainland. Figure 4 shows the key employment hubs in the city and the main road networks and ferry hubs providing connectivity.

Figure 4: Kochi's key employment hubs and road and ferry connectivity

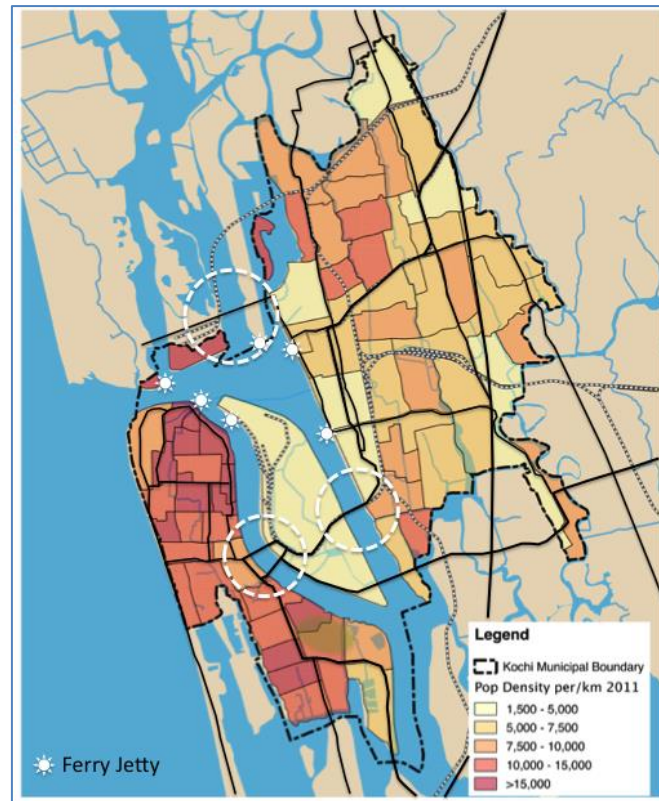


Source: Authors, based on information from Development Plan For Kochi City Region

Although historically well endowed with canals and waterways, the popularity of waterways for transport has declined over time in the region. Kochi, which had more than 60 jetties in the backwaters (CDIA, 2010), used to have an extensive ferry system, transporting passengers and goods to urban areas and nearby districts. As the city developed, there was a marked improvement in road-based transport in the city. The construction of bridges connecting islands to the mainland was the most important factor in the modal shift from ferries to road-based transport (Joseph, 2012). It resulted in a substantial rise in private ownership of vehicles in these islands as well as use of bus transport systems. The pre-feasibility study for ferry services in Kochi (CDIA, 2010) reported that in 2008, over 2,200 daily bus departures were recorded from key island locations to the mainland, a number that must have increased since. As illustrated in Figure 3, only 3 per cent of the commuter traffic now uses ferries for travel. This is despite the fact that, if efficiently operated, ferry travel would take substantially less time than road travel, especially with the congestion the bridges

now face. However, there were several reasons for the shift, the most important being the poor state of the ferry infrastructure, inadequate frequency and unreliable services (Joseph, 2012).

Figure 5: Connectivity in Kochi City



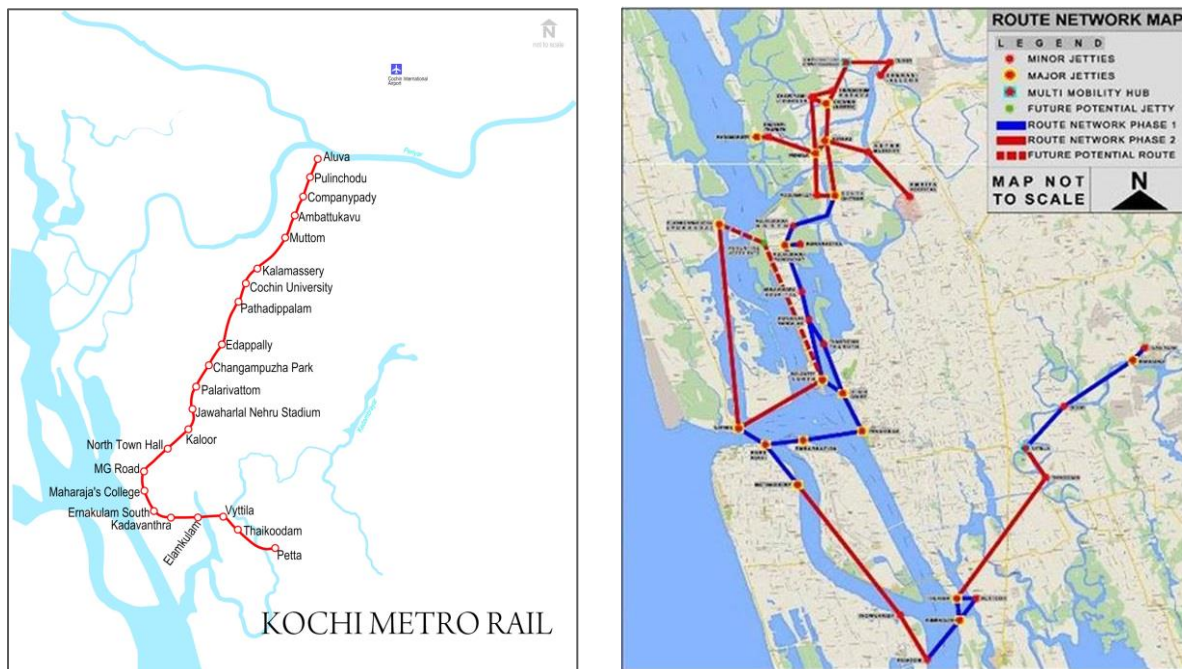
Improved connectivity between the city centre and the densely populated areas of Fort Kochi/Mattancherry and Goshree islands on the west through new bridges and roadways (highlighted in white circles) has redirected passenger traffic from ferries to roads that allow for door-to-door connectivity.

Source: Authors, based on information from Census 2011 & Development Plan For Kochi City Region

A recent development in the city's transportation system however, is expected to have a positive impact on this declining mode. Kochi has a new metro system, introduced in 2017, which augments the city's public transport supply (Figure 6). The system, developed by the Kochi Metro Rail Ltd., has a north-south emphasis along a 25.61 km corridor from Aluva to Petta near Tripunithura with 22 stations en-route. It is projected that the system will enable up to 30 percent modal switch from road-based transport to the metro in the mainland (KMRL, 2013). Although the metro project does not currently extend to the islands and western part of city, these areas, which are densely populated and comprise a major share of intra-city travel, can benefit from an efficient waterways system working in complete tandem with the metro network. KMRL, the agency in charge of the metro project, has acknowledged this potential and proposed a "water metro" project that aims to overhaul the existing waterways system in the city and provide cross-modal connectivity with the metro. The project envisages 16

identified routes, connecting 38 docks across ten islands and spans a total route network of 76 km to be implemented in two phases and aims to be fully operational in four years. Figure 6 shows the proposed network along Phase 1 and 2. It not only builds on the existing routes but also proposes some extensions to the current network in the north and east. To facilitate coordinated planning and implementation of these transport projects, and integrated management of all transport systems, KMRL is also pushing for the creation of a Unified Metro Transport Authority (UMTA) for Kochi, an umbrella transport agency envisaged under the 2006 National Urban Transport Policy.

Figure 6: Phase 1 of Kochi metro project operating since 2017 & Phase 1 & 2 of proposed Kochi water metro project.



Source: Wikipedia Commons⁶ & The New Indian Express⁷

A modal shift away from road transport would relieve the city of the extreme traffic congestion that it is experiencing now. It also builds on Kochi's potential to becoming the principal node of hinterland connectivity through inland waterways in Kerala. NATPAC (2014) has reported that development of Cochin Port-hinterland connectivity through inland waterways could bring in an annual economic benefit of Rs.442 crore, in addition to several other tangible and intangible benefits. Water based transport also holds great potential for the tourism industry in the city. Kochi, which is already a favoured tourist destination, could gain immensely from an efficient inland waterways system. This is also crucial for regional development as the Kochi-Alappuzha backwater belt is amongst the most popular destinations in the tourism map of Kerala. It is also opportune since the city is currently

⁶ Kochi Metro Route Map [Image]. (2013). Retrieved from <https://commons.wikimedia.org/wiki/File:Kochi-metro-route-map.png>

⁷ Water Metro Route Network Map [Image]. (2016). Retrieved from <http://www.newindianexpress.com/cities/kochi/2016/aug/17/Water-Metro-Charting-routes-1510086.html>

witnessing a socio-cultural revival with initiatives like Kochi-Muziris biennale. Efforts are also underway on a large scale to conserve heritage properties and monuments in the city. The restoration and revival of Kochi's water bodies is elemental to these efforts.

The renewed focus on enhancing water transport systems, as part of an integrated public transport network with the metro and bus systems, thus holds promise and helps Kochi build its social, economic and climate resilience to safeguard itself from extreme events that threaten to interrupt the city and its economy.

6. Limitations and Challenges to development of water ways in Kochi

6.1 Institutional Limitations

Due to its regional nature, a range of agencies have jurisdiction over various aspects of the water transport system – setting up terminals, dredging, licensing, operating passenger services, etc. These overlapping jurisdictions have led to institutional complexities and the inability, so far, to deliver a unified, co-ordinated system.⁸ An Urban Metropolitan Transport Authority (UMTA) integrating the metro, bus and boat transport modes has been proposed by KMRL, but the bill for setting it up is still under the consideration of the state government. In its absence, Kochi Metro Rail Limited (KMRL) is acting as the co-ordinator to streamline works for the new metro and the proposed supporting water transport systems.

6.2 Network Limitations

One of the limitations of the ferry service is lack of permeability within the urban fabric of the city through internal canals. Water transport systems in cities like Amsterdam and Venice have been successful due to a large network and connectivity to different parts of the city. Even then, water systems find it hard to compete with the convenience provided by the door-to-door connectivity of roadways. In Kochi's case, the western edge provides a good front for water transport but there is limited scope for extending these services to the inland canal system. This is because the naturally occurring inland channels in the east, in areas such as Ernakulam and Kakkanad, are narrower and do not have the required navigable depth or formal edges. Unchecked encroachment through illegal construction activity and dumping of solid waste has further reduced the capacity of these systems to support transportation. Considerable investment will be needed to formalise these inland waterways and make them navigable.

As a result, much of the current passenger and goods water transport network in Kochi as well as the proposed enhancements by Kochi Metro is concentrated in the west coast canal, connecting the mainland on the east with Goshree, Fort Kochi and Mattancherry areas on the west. Since Fort Kochi and Mattancherry are the most densely populated areas of the city,

⁸ Multiple agencies with a stake in Kochi waterways include the Inland Waterways Authority of India, Greater Cochin Development Authority, Goshree Islands Development Authority, Kerala State Water Transport Department, Kerala Shipping and Inland Navigation Corporation, Cochin Port Trust, Department of Irrigation, Government of Kerala and Corporation of Cochin. For a detailed commentary on functions of various stakeholders, refer to Joseph (2012)

providing alternate connectivity to these from the mainland is a priority from both a demand management and resilience perspective. Being part of National Waterway 3, this channel also has national support for regular maintenance of navigability. A parallel can be drawn here with Seattle, where the city runs a successful ferry service between the mainland and the islands off Puget Sound, saving commuters from the congestion on connecting bridges. However, barring the case of waterfront activities that generate or attract traffic and can be served exclusively by ferries, the role of the ferries is limited to being a link in the trip, its success dependent on the efficiency of the connector or feeder systems that start or end journeys.

6.3 *Ecological Limitations*

While there is need to restore and improve the natural waterways in the region to augment connectivity and build resilience, their suitability for transportation needs to be viewed with caution, taking into account the socio-ecological impact of action. By virtue of their location, high productivity and services provided, estuarine ecosystems worldwide are often subjected to severe ecological pressures (Kumar et.al, 2013). The Cochin backwaters too are an important resource that offer flood protection and support the local economy. Small scale fishing, farming (pokkali paddy and prawn alternating cultivation), cottage industry using brackish water for coir processing and local ferry services have been the traditional activities in the backwaters, enjoying a symbiotic relationship with the water system. In contrast, modern uses such as large industries, ports, large-scale mechanised fishing and tourism and increasing urban pressures (reclamation for development, transport, dredging, sewage and waste disposal), have led to pollution of the backwaters and encroachment and deforestation in the hinterland. Large scale reclamation and dredging to make these systems navigable have already caused significant destruction of the mangroves that played a vital role in flood protection and in sustaining the ecological balance of the area in and around the backwaters (Thomson, 2002).

The sensitivity of the ecosystem thus needs to be taken into account while considering the use of these waterways for transport, especially those more inland in the east. Uses that complement their ecological value, such as non-motorised transport for local communities or tourism purposes, may be a better fit for the eastern inland waterways, building on the economic value of the resource in a sustainable manner. Even in cities like Amsterdam, Bangkok, New Orleans, Birmingham and others with natural or man-made canals, the canals are rarely used for daily commuter transport these days, but are more for recreational, leisure and tourism activities. Even so, with regular upkeep, these systems do retain the potential to be used as such in extreme events such as flooding, thus contributing to the city's resilience.

7. Conclusion

The resilience of any city is a function of both its ecological and economic system. It should be understood as the ability of the locale to counter both climate and economic shocks and its capacity to constantly renew itself to withstand an ever changing set of risks. Processes to enhance resilience should factor in both the aspects. The city of Kochi has much to gain from

the development of waterways. A sustainable water transport system will invariably mean the revival of natural water channels in the city and the creation of climate- proof infrastructure; the twin benefits would be an efficient transport system and increased resilience. The degradation of the water system in the city has not only raised its vulnerability but has also compromised its resilience capacity. In the case of Kochi, even when the importance of its water bodies is appreciated at the policy level, the approach towards their regeneration or maintenance has been ad hoc. While the present water metro project envisaged is praiseworthy, the emphasis seems to be more on the economic aspect, especially the ease of transport in the city. Global practices indicate that it is, in fact, possible to reap the economic benefits of improved waterways without compromising on the environmental agenda. In a city like Kochi, it has to be noted that both aspects are highly intertwined and support each other. Environment sustainability need not exclude the multiple economic benefits that development brings. Any approach discounting the importance of one or the other will limit the true potential of the city. The limitations the city faces also calls for an integrated approach with the involvement of all stakeholders. Above all, development of an efficient water transport infrastructure is a unique chance for Kochi to right the wrongs of the past and prepare itself better for the future.

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