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Centre for Public Policy

# M.R Krishnamurthy Memorial Lecture

## on "Making Bangalore an Ecologically Smart City"


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First of all, a thank you to IIM Bangalore, the Centre for Public Policy and to Prof. M.R. Krishnamurthy's family. It's a pleasure to be giving this lecture. Actually, when Prof. Gopal Naik reached out to me, I was just thinking that there was no way I was going to say no to this. To let you know why, I will need to share a little bit of my personal background with you. My father worked in HAL and the Aeronautical Development Agency, and we host a memorial lecture for him in the Institute of World Culture annually - it's a very special program for us as a family. So, when you reached out and said that it was in memory of Prof. Krishnamurthy, it was a real pleasure, and I am very happy to give the inaugural lecture. Thank you for this invitation.

I think it is a wonderful idea to give a lecture on the city, as a tribute to someone like Prof. Krishnamurthy, a resident of the city who loved Bangalore, I am also a resident who has a lot of love for the city – and I think most of us here are people who share the same passion for the city – and the same sense of loss or pain, shall we say, if you look at what the city is going through today. So, this is really what I wanted to talk about: to describe how the city has changed, do a little bit of a deep dive into the ecological history of the city, and give you a sense of what has changed over time – and finally, end with some reflections of what we could do to make the city a better place.

First, to start with a little bit of a background. We are in an era that scholars and geologists call the Anthropocene. Depending on where you want to put the origin of humankind, somewhere around 100,000 years ago, the first human-like being came on the planet and they remained in different stages, places but about 11,000 years ago to 8000 years ago we had a period of really favourable climate - it wasn't too hot or too cold. The climate was relatively stable. This was when we entered an era called the Holocene – which was so favourable for humankind that we could spread across the world and begin to transform the earth's cover through agriculture, cutting down forests, expanding pastures and eventually building cities. It is this kind of urban growth that has led to dramatic changes on the planet. For instance, the weight of all the plastic we produce is more than the weight of all living beings on earth and in the sea. So that's the kind of impact that we have on the planet. In response to these changes, geologists finally came together and said that we are in a new era, an era called the Anthropocene where urban growth has led to major dramatic human transformations on the entire earth's surface. This is a night light satellite image and what it shows you is where all these brightly lit spots are, and you can see India very brightly lit*. In fact, what is interesting is that the fastest urbanising countries are those in what you call the Global South: India, China and Nigeria. These are the kinds of places that are really growing fast. We are already a world that is more than 50% urban but by 2050, which is not that far away, we are going to be a world that is 75% urban, which anticipates even more dramatic transformations to our planet. People estimate that cities will occupy at least 2 ½ -3 times of land surface area as

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they do today which means that there is much more city or urban space to be built than there is already. All of this will take place at the expense of massive conversion of forest in rural areas and it requires a lot of industrialization. It is already leading to a lot of social and ecological vulnerability, a lot of inequity and this is only going to grow worse – and yet it does seem like urbanisation is an inevitable process. It is a juggernaut that we have set it into place and there is no real alternative. We would like there to be alternatives that are, for instance, looking at the growth or strengthening of rural economies and we do hope that those explorations will continue but it seems that urbanisation is going to be a force to contend with for a long while. This is especially so in what we call the Global South, a term that encompasses areas that we used to call developing countries in an earlier time.

If you look at this map, which is from the UN Human Settlements Report, you will see that the cities marked in red and yellow, which are the fastest growing cities, are largely located in the Global South, in India and China and parts of Africa. India already has three of the world's ten largest cities, as well as three of the world's ten fastest growing cities and contains most of the world's most polluted cities – now having overtaken China in this dubious race.

Definitions of the urban vary. India has its own, very specific definition of cities. But if you use a standard UN definition of urbanisation, you might find that India is not 33% urban as we have been told but is 45% urban. We have a number of small towns that are growing into tier-3 cities, and tier-3 cities that are growing into the tier-2 cities, which are going to face some of the greatest sustainability impacts – because those are the ones which are the least planned. I do not mean to say that larger cities like Bangalore are extraordinarily well-planned, but at least there is some thought that is given to issues of basic infrastructure such as sanitation, sewerage, roads - many of the smaller cities simply don't have the money to do such planning and provisioning. Urbanisation in countries like India is very different from Global North countries. We are under-provisioned, we don't have the administrative expertise often, we often lack adequate technical and financial capacities, we have very, very dense populations and we have unprecedented rapid growth rates which are well beyond what the Global North is experiencing. So, for instance, here is a map that shows night light satellite image maps of India juxtaposed with the southwestern US. This is a map from NASA that shows you changes in light cover: where are lights going on over the world and where are lights going out. You can see that lights are coming on in many parts of India - so most of it is blue. Large parts of the US are pink. These indicate areas that are de-industrialising, and you will see, for instance, Texas or Detroit or many other cities in the US are actually shrinking cities. Large parts of the US are shrinking cities. When you look at the urban literature on those places, they are looking at how do I deal with high crimes, how do I deal with an inner-city part complex which is de-urbanising, which is

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de-populating. And we are looking at completely different problems of rapid population growth and rapid expansion of cities. This is not just a recent development. It's not that global cities in the Global South are growing faster now. In fact, we did an analysis in 2018 which we published in Nature Sustainability where we wanted to spotlight the urban South and the predicament it poses to global sustainability. This is a box and whisker plot. Essentially what it tells you is very simply that the green which is the cities in developing countries of the Global South always had higher population growth rates, whether it is in the 1970s or from current times. They've always been growing much faster; they are much denser. They also have very different social and environmental contexts. For instance, youth unemployment, under-5 mortality rate, poverty, slum households, access to sanitation, bad air (PM10 concentrations), low internet access, high homicide rates and low literacy rates. Cities in the Global South simply have a very different administrative, financial, technical challenge on their hands because they have a lot of people, many more than the Global North. Population densities are high, capacity to provide basic infrastructure like sanitation, sewerage, roads, electricity is very low, under-5 mortality rates are high, pollution is high, internet access is low, literacy is low and so the challenge of urban sustainability becomes even more dramatic. And you can actually see this in Bangalore. For instance, the place where IIM is located or the place where I live, which is in Sarjapur road, the peripheral parts of the city are actually much worse than the central parts of the city. The central parts of the city were relatively well-planned at a time when the city wasn't urbanising so fast. They have their green spaces, they have some degree of public transport, though not excellent, some walkable pavements, reasonable access to water and sanitation. And for the peripheries, no norms were followed, it has grown the way it has grown. Infrastructure comes later to back-fill the spaces and then it is obviously not going to be ideal. It's very unsustainable.

Given the context of these cities we need to understand how to plan them, and a lot of the planning literature comes, of course, from academic publications on sustainability and so we looked at where the data was. We did an analysis in the same paper where we looked at the top-1000 papers on sustainability. These are the top-cited, the most influential papers on sustainability over a 10-year period from 2008-2017. And we found that almost without exception, 70% of them were from or by people working in the US and Europe, 0.1%, 10 out of 1000 papers were from India. China forms a specific case of its own. There, 20% of the papers on urban sustainability are from China by Chinese authors. The Chinese government supports a lot of urban sustainability research, also training its urban administrators and planners every year based on their research – which in part explains why you see so much research from this country. But if you take South Africa, India and other countries in Global South with similar contexts, it's 0.05%, that is 50 out of 1000

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papers. This is a tragedy because if you look at the urbanisation of the future it is going to come from countries like these. Yet we are getting our lessons in how to think about sustainability, what to do with sustainability, from papers in contexts which are not ours. And which makes sense because if I were to ask you to pick a city anywhere in the world, you will probably pick a Paris or a Toronto or a New York. You are not going to pick a Bangalore or a Belgaum. If you look at which cities are studied, not just where the authors are from, only 7% of the cities are from the Global South, 23% are from the Global North, 21% are Chinese cities and 49%, about half are multi-city or global analyses. What happens to a Hyderabad or a Ibadan (Nigeria) or a Belém (Brazil). We do not know anything about what drives these cities or what makes them tick. Not just what makes them tick from an infrastructure, financial, legal, policy perspective but what makes them tick from a cultural perspective because cities are, at the end, cultural entities and the way people govern them and drive them and what they do with them is a very culture-specific thing. That leads to ill-fitting solutions, which I will discuss later. For instance, the smart cities program, which is so focused on technology. I will give you examples of some cities where we did interviews in Karnataka. But look at the kinds of discrepancies we have to begin with. A recent paper in PNAS said that per capita urban infrastructure is 600m3 per person in the US, 20m3 per person in Bangladesh. You have very basic problems. You don't have enough place for people to live in. And then smartness comes on this. But if you have potholes, and you don't have basic amenities like water or electricity, these might be much more urgent problems to deal with than the smart cities. What I really want to argue in the rest of the talk is that an ecological smartness of going back to our roots is very, very important and this is where we can learn a lot from Bangalore. By 2050, 60% of India will live in cities. This projection may vary but somewhere around 20%. That means 900 million additional people will be in Indian cities. Some of this is endogenous growth – people will reproduce, more children will be there – but a lot of it is migrants and a huge number of them would be climate refugees because of climate change going on in the background as this is the era of the Anthropocene. We are seeing this already in a lot of places, in rural areas, they don't have water, they don't have agriculture and so people move to cities. In fact, we did a paper with Choksi et al with colleagues in Columbia where we showed that a lot of people in north India have seasonal migration because of climate variability. But even to be a climate refugee moving to a city and trying to make a buffer, we need some kind of social and economic capital. So, the poorest of the poor are, in fact, not even able to migrate. They just stay where they are and maybe die of hunger. And the ones we see are still very poor but at least have some capacity to move to cities. So, cities have to think of their spaces in the larger Indian landscape and how they are going to deal with these climate refugees and give them a decent quality of life.

Cities also impact Indian biodiversity. In

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fact, we are working on a paper right now where we are intersecting cities and their boundaries with protected areas in India. And India's protected area management strategy or conservation strategy has always been to remove villages from protected areas and create "inviolate" protected spaces. You can't do that anymore if a city is at your doorstep. You can't relocate cities. And what we find is that 40% of India's parks are 60 kilometres from a city, an hour's drive away, which means in another three years the city is going to be on their doorsteps and this really impacts the way India thinks about conservation.

While I am going to talk about Bangalore, I just want to broaden the debate a little bit before I plunge straight into Bangalore to tell you that what's going on in Bangalore is also impacting what's going on in all of India because cities, of course, are the biggest sustainability drain on a landscape. They bring their food from somewhere, they bring their water from somewhere, they send their waste outside. They don't just impact the landscape where they stay but impact this larger landscape around them.

What happens within the city? Within the city you have huge inequities. You have some people living in very luxurious settings while there are others who have to deal with heat islands and flooding and air and water pollution. But also like you had in Bangalore, very recently last monsoon, you have the Bellandur lake which overflowed and Bellandur-Varthur, the entire chain in between them overflowed and the city was flooded. Apartments next to us were flooded so much that people were taking coracle boats and moving them into the city. This is, of course, because we built on wetlands. But this is also telling you that while it's true that the worst affected are the poor in the city but the kinds of impacts we are seeing now is that everybody is affected. It's not that you can really stay isolated from these settings and cities. So, for resilience to climate change and future shocks, the argument I am making is that we are talking about urban regional planning as though ecology doesn't exist. We always do that and then retrofit ecology back later. But ecology is central to shaping people's lives and culture and wellbeing and this is something Bangalore really, really shows us.

To tell you a little on why I got interested in cities, I started my own journey when I began working in 1994 at the Indian Institute of Science looking at forests and polycentric governance and collective action and then worked later at the Ostrom workshop in Indiana University with Elinor Ostrom looking at Nepal and India and forests. One of the things I am very interested in is that people are always blamed as the cause of environmental deterioration, but people are also the solution as Commons action, collective action shows us. One of the things I strongly believe in is not just that the ecology is central for the survival of cities but people and their connection to ecology is very central. If you want to protect nature in the city for the survival of cities, you must remember that nature in the city is part of culture in the city and so how do you maintain these as social,

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cultural, ecological spaces. In 2006, I started working on cities as well because I was working on forests from about '94 to 2006 (and I still of course work on forests). But I started working with others on restoration of a lake in my neighbourhood and, in Jayanagar, which is where my mother's house was, started working on the movement to save trees. So, my interaction with urban ecology really didn't start as a researcher. It started more as an activist, as a citizen and someone participating in lake movements. But then I started putting together a lot of different methods since my own training is in landscape ecology using GIS and remote-sensing and working on the commons and biodiversity. But history was something that I found was a very good hook because when you start working on ecology and in a situation where you want to talk to people, everyone is interested in history. And so that's the first thing we started doing. But in a city like Bangalore (it's unfortunate but true that we are an IT city and should have better ways of tracking our history) we don't have basic information. We had to go back to some maps and also things like archival data, oral histories, songs, and other non-conventional ways of doing research which is a very Global South issue actually. When you are data-poor, you have to find alternate ways of finding data. And underlying this is the idea of landscape ecology which is how to link patterns and processes to understand what is sustainable in governance of the city as well as collective action and polycentric governance. In 2006 I started working on lakes and by 2009 or so I started looking at lake collective action more from a research problem perspective in addition to being on an action perspective. What I'm going to show you is some of the results of the work done from 2006 onwards which comes to that "where's the data" story. And what you really find is that the story of Bangalore is a very interesting one. It's a city that grew because of biodiversity, it is a city that grew because of its ecology and what it does is challenges us for standard perception. When you talk to most people, they would say, yes, it's very sad that Bangalore's ecology has deteriorated, but what do we do; we are a city, we have to grow, we need development; we can protect ecology outside the city; we can go to national parks outside; or we can protect the ecology of the city later once we grow but right now the problem is lack of growth, lack of economic opportunities, we need to grow. This is a very standard statement. But if you look at the deep history of Bangalore, they didn't grow that way; they always grew by protecting, nurturing, and adding to the ecology of the city. It grew because of its ecology. It's only in the last few years that we have forgotten this lesson and so it's really a mindset issue, in some sense, to look at the kind of rapid scale of growth and to understand that places of nature were places that communities managed. So that's really the story of Bangalore that I would like to tell. And this draws on two books of mine: Nature in the city is the deep ecological history of Bangalore from the past 1500 years or so; Cities and canopies is more about trees in Indian cities not just Bangalore, but a lot of the work on

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Bangalore.

This is the map of Bangalore, which is mapped by a colleague of mine, H. S Sudheera, and if you look at the maroon spot in the middle, that's Kempe Gowda's Bangalore. And if you hear the history of Bangalore or look at Wikipedia, what will you hear? You will hear that Kempe Gowda was a visionary, he came to this barren landscape, he saw a hare chasing a hound which is a common folk myth in this entire southern region (not just South Indian) but in the larger Asian landscape where a hare chasing a hound is a sign of bravery. In fact, even in Rome you will see this. There are similar myths everywhere. And so, Kempe Gowda came, and he saw this land and he said this is a site of bravery and as a warrior, I can create a kingdom here. He yoked four oxen into four different directions and where they stopped at the end of the day were the boundaries of Bangalore. He must have been a visionary, no doubt, but it's not true that there was nothing in this land before he thought of building a city. You look at how Bangalore has grown over time, and it has grown hugely, but what was that small spot and what was in this larger region of Bangalore. This is a digital elevation model of Bangalore and from this you can see that it has an undulating terrain. Bangalore is an odd place to have an ancient civilization. We have megalithic stone tombs with menhirs, and if you go to Avati and areas near the Bangalore airport, you will see these slabs of stones sticking out of the ground. These are megalithic stone tombs, and they will tell us along with other rock paintings and things that people have found that there were people living here somewhere around 1500-2500 BC. Who were these people, we don't know. What were they doing here? It's a little strange because Bangalore is in the rain shadow of the western ghats, so it doesn't get much rain, nor does it have any perennial sources of water. So, what were people doing without perennial sources of water? How did they live? The first thing we hear is ancient civilizations come up on the side of the water streams and it is not like rivers' courses changed. There were never, or at least in those times, no perennial sources of water. It's also far from the sea.

Then we find that around the time between the AD and BC transition, there were a number amphoras full of different coins that date to this period of time – like 100 BC-100 AD – from different parts of the world which seems to suggest that Bangalore might have been a trading center.

Why was it a trading center? There is nothing that survives today, no information that tells us – no overland roads – nothing that it was close to. Again, it's all a mystery. From 500 AD or thereabouts, we start finding some inscriptions on copper plates and stones which start giving us a sense of settlers in the landscape and these can be of various kinds. But the location where the inscription was found gives you a sense that there must have been a habitation there. So, I took the locations of these copper plates and stone inscriptions and overlaid them on this digital elevation model to understand where people came in (this was just before Kempe Gowda).

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There were four different dynasties – the Gangas, Cholas, Hoysalas and the Vijayanagar empire, and Kempe Gowda was part of the Vijayanagar empire.

We will start with the Gangas. What do you get? The first thing is if you look at this map of Bangalore and remember, I put the boundary of Bangalore, but there was no Bangalore in the 6th century. This gives you a sense of what landscape Kempe Gowda and, before him, the Ganga kings and chieftains came into. You will see that it was an undulating landscape. In fact, when the British came into Bangalore, one of the first things the local people told them was that there are two parts of Bangalore: there is the maidan, or the bayilu or the flat landscape to the east and there is the malnad or the hills which are granite rock areas to the west. So, much more rocky, hilly to the west; much more plain, flat to the east. Those of you from old Bangalore will remember that the city used to be very mountainous and hilly and now we have actually blasted it and filled in the lakes and it's a much flatter city than it used to be. When you used to drive through the city, it was very common to see these very large granite boulders. These are actually two different ecologies, and it is much easier for people to settle in the east because that was a flatter landscape where you could actually get more rainfall and you could farm more easily. When the first settlers came in, it's no surprise that they settled in the maidan or the bayilu, not in the malnad or the hills. Then by the 10th and 12th centuries, the Cholas came in and they started moving a little further but still in flatter landscapes. By the 13th and 14th century, suddenly there was this spurt of growth when the Hoysalas come in. How many of you have seen the movie, Ponniyin selvan? So, all of those lovely landscapes that you see with irrigation tanks, this is something that the Hoysalas did. They created these tanks in a network of irrigation systems. When you had a dry landscape and you had water at a higher level and your lake overflowed, it would overflow through these channels or kaluves to the next lake and the next lake and the next. So, these were interconnected hydrological structures. Many of them were very small ones, kuntes, which you had for cattle washing or washing clothes and then you had the very large ones which all ended in the word sandra. See the first one Hongasandra. Sandra is a corruption of the Sanskrit word samudra which is not just ocean, but it means a large body of water. The place where I live there is Singasandra, Mallasandra, Junnasandra. None of these exist. All these sandras basically tell you that there were once lakes that don't exist anymore. (Pointing to the slide being presented) Belur-nagasandra, 16, then Mallasandra, Singasandra at 19 and 20. So many of these lakes went hand in hand with the expansion of Bangalore. They now start moving up into the hills because place is scarce now, and all the best places have been taken. And then by the time of the Vijayanagar dynasty, there are at least 75 villages in this area. At least 75 villages in these inscriptions. New ones are being discovered all the time. We really don't have a track. Many of the old inscription stones that are documented in Epigraphia Carnatica have actually

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vanished. In fact, there is a really interesting group with a Facebook page called Inscription stones of Bangalore. There are volunteers who find these stones, save them, keep them in the local landscape and tell people about their micro-histories. This is what you have. Kempe Gowda must have been a visionary but could actually come in because there were already these 75 villages thriving in this area. In fact, when he actually founded Bangalore, Achyuta Devaraya, who was then the king of Vijayanagara empire, gave him a jagir of a number of villages in this area and said that the income from these villages is yours because you have created this new city called Bangalore. What were these villages doing, though? They were managing because of lakes, and they were creating lakes. For instance, near Agara lake, there is one of the oldest inscriptions that we know of which references lakes in 870 AD and it says, "be it well in the particular year, Nagattara, who was the king and the local chieftain, Irugamaiah's son, Sirgamaiah, fixed sluices to the two tanks". So, there were at least two tanks in Agara "and had the eastern tank built", so there were three "and obtained the bittuvata" which is basically the right to tax exemptions. You have helped to build a tank and then you get a tax rebate for a few years. It's very much like you have a solar panel and you get a tax rebate. What are these three tanks, we don't know. Some historians speculate that they were probably Madiwala and Bellandur, but others say no it would be too far away for something like an inscription in Agara to talk about. So, it probably refers to tanks that are no longer there. They have been lost completely; we don't know. This inscription stone is, by the way, no longer there. When Agara lake was being restored, not now but in the previous restoration, it disappeared somewhere, and nobody knows where it is even now. We just have this documentation because Lewis Rice documented all of this in Epigraphia Carnatica couple of centuries ago. But you also have inscriptions like this in Vibhutipura village near the HAL airport which tells you how they did it. This is what it says that this particular person having "cleared the jungle in the tract of land, levelled the ground, built a village, constructed a tank by removing the sand and named the village Vachchidevarapuram" which they granted to the God, Vachchidevara. And the temples were the largest landowners in this region, so they granted to the Vachchidevara, the village and the wet and dry lands adjoining it with their four boundaries. It gives an exact insight into what they did. They found the low-lying spots, cleared the jungle, levelled the ground further, built the village, constructed a tank by removing the sand. And then you can actually grow paddy in the areas below because you otherwise had millets in dry areas. Not just paddy, you could have orchards, coconuts or flower orchards. There is another inscription which talks about Kempe Gowda's mother owning flower orchards in the landscape around this area. Economies grew like this. And that's when you had silkworm, and the entire economy of Bangalore was possible through these tanks and irrigation systems. This process continues till

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Kempe Gowda comes in and then after about four generations of the Kempe Gowda dynasty you find that the last one, Magadi Kempe Gowda, is defeated and moves to Magadi because Shahji, Shivaji's father, comes as the head of the Bijapur sultanate army and takes over Bangalore. As a reward, he is then granted Bangalore as a jagir. Shahji rules Bangalore from 1638-1670. Shivaji was actually married here, and Shivaji's younger brother gets the jagir of Bangalore. The Kadu Malleswara temple in Malleswaram, has an inscription there that talks about how Venkoji, Shivaji's brother, comes to that landscape and people tell him about Kadu Malleshwara and he creates a temple and grants it to the local people there. There is actually a stone inscription there which you should go and see.

But importantly for us to know and understand Bangalore, there is this Sanskrit poem, "Shivbharath", written by Parmanand, Shahji's court poet. Written in 1670, the poem talks about the period 1638-40, the time that Shahji first came to Bangalore. And it tells us apart from the inscription, the next knowledge and how Bangalore as the city was looking. It talks about Bingrule, which is what the Marathas called it, the matchless city with smart fortifications and towers, but look at the ecology embedded through this description:

"That sounded with content coos of countless pigeons safe in their nests/ animated by the calls of peafowl dashing in and out of skylights/the city teemed with deep lakes, each house was graced by a well/fountains gurgled at every square spouting a fine mist."

Incidentally, about 10-15 years ago, I met Prof. Ramachandran who headed the Geological Survey of India. He was 94 or 95 years old then and he said that till the 1960s Bangalore used to have fountains at every square with this mist. And Chamrajpet, for instance, always had these fountains in summer.

"Trees thick with flowers and shade lined each home garden/the city was girdled by a bottomless moat glimmering with water/ with countless lakes each as big as the sea/picturesque parks festooned with creepers swinging gaily in the breeze all adorned the city/"

And of course, since he is the court poet, he has to praise Shahji at the end, "He ruled here as Indra in his paradise enjoying every sport and pastime as kings would."

But you get the sense clearly of a city that is embedded in nature, that nature is in every part of the city – the home gardens, the wells, the fountains with mist, the peacocks, the pigeons, the city with the countless lakes, the parks with the creepers. It is everywhere through the city. We don't have much more information. We know there are a lot of lakes, we know there are some parks, home gardens and there are trees.

But what happens to Bangalore after that? It continues to change a lot of hands. Shahji gives it to Venkoji, then the Marathas actually sell it to the Mysore dynasty. In between, the Mughals come and take it over for three years, then they sell it again back to the Mysore kings, and then Tipu and Haider, come and then

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the British keep coming in and out. So, we know very little of what's going on. When I say "know", there are a lot of myths and legends and it's very hard as a researcher to try to separate what is myth and legend from what is fact. But what we do hear constantly through these tales is the fact that each of these rulers wanted to protect lakes. We know that lakes were a big line of defence as well as a casualty during the Mysore-Maratha wars and the Anglo-Mysore wars. During the time of Hyder and Tipu, they were constantly fighting the Marathas and also fighting the British and the Marathas and the British finally got together and were ransacking Bangalore. And each time, whether it was the Marathas or Hyder and Tipu, one of the first things they would do is breach the lakes, poison them and the wells because then the opposing army which came in would get starved out. But as soon as that particular battle or war would be fixed, you would find that Hyder and Tipu were back at work restoring the lakes. There was a lot of lake construction, lake maintenance, well-maintenance going on during this entire time. You know that through Kempe Gowda, to Shahji all the way to Hyder and Tipu there was a lot of value placed on these lakes and water bodies and very naturally so because in a dry landscape what else would you find. When the British came after the 3rd Anglo-Mysore war, they had Bangalore for about 20 months and, the first thing of course the British do was draw maps, which is very useful for researchers. This is the map of the city in 1791 and it is not to scale. I have drawn the boundary of what the cantonment is but there was no cantonment then, just a kind of locator of the space. There is a pete, the Fort and you will see a few trees along roadsides, trees in bunches where there are orchards. In fact, some work I did with a colleague, Meera Iyer, shows that this landscape, (pointing to the slide in the presentation), you see these square patches here, these square patches are actually Lalbagh. This is how little we know about the history of Bangalore. We have this history that Lalbagh grew very linearly from one patch of Hyder's to a second patch of Tipu's to the British adding one more patch, a major war added a 3rd patch and then it grew to a 4th and then finally to the Lalbagh that we have. We find through these maps, and we published a paper that showed that of the five patches in that area, which were all royal gardens, very Mughal (with the duibagh, charbagh) and Islamic gardens in the landscape structure, only one survives today in Lalbagh. The remaining four are completely lost.

These are the old gardens of Hyder and Tipu and we have lost four of them and we don't even know. And the one that we have is not in the place the official documents will tell you old Lalbagh is. It is actually in a different part of the landscape.

What you can see here is a landscape of a lot of lakes which are still very important, and you can see the interconnections of these lakes. The next map I want to show you is of 1888. By now the British are here. They are planting trees everywhere because Bangalore is very hot, and they also create a lot of lakes. This large lake here is Ulsoor lake and it's because the British set up their cantonment very close

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to Ulsoor lake and they need this water, that they actually expand on the lake. They build a lot of different water places. For instance, behind Cunningham Road they have the entire Millers tank series, and we don't know for sure but Kaikondrahalli lake, which is close to where I live on Sarjapur road, local legends tell you that it was built by the British in the 1920s. Now we don't know if that's true or not but at least the jogidar, the family that owned the rights to the villages around, say that this is what they have heard. A number of lakes were created not just in core Bangalore but also in the periphery by people. This is the point I want to make. As more people came to Bangalore, they created more water bodies because they knew they were dependent on these water bodies for water and for sheer survival. They also planted more trees because they knew they needed the shade because as your city is growing you need that. In fact, in the 1860s you start hearing the British talk about climate changing and they said that it used to be so cold in Bangalore that the sepoys could scarce fire their muskets in the morning because the fingers would be frozen with cold, we used to have fireplaces in homes to heat them. And now it's so hot we can't step out, so we need trees to cool this city. And so, they start planting all these trees. And because they are the British colonial empire, they have a palette of flowering trees to draw on from across the world. They plant trees like the rain tree and the copper pod which are mostly evergreen, not deciduous – because what you would have already had in a dry deciduous landscape like Bangalore are thorny trees, which will not give you the much-needed shade that the British desired. They bring these large canopy trees that give you shade. A lot of trees, a lot of lakes and then what happens, sometime in 1890, Col. Sankey then constructed Sankey tank, as it was called then, and he says, that's it, we have run out of space. There is no more space in Bangalore to create anymore lakes. This is the last one that we could actually create because there are people everywhere else, and all the low-lying areas have gone. But the city is still growing. Then between 1889 to 1892, there is a drought for about three years, and they try all kinds of ways to provide water to the residents of Bengaluru. For instance, we have done some research on Dharmambudhi lake, which is now the Majestic bus stand, and what they do is, because that area has a lot of people, they pump water from Sankey which is below the topographic gradient, up to Dharmambudhi, and then distribute it to nearby homes. They are doing all kinds of innovative things to try and manage the water supply. But in 1892 they realise that they need to do something to expand the city's water supply – and then the Mysore administration under the Maharaja devises the idea of getting piped water in from the Arkavathi River, a few lakes near the Arkavathi. The original plan is to supplement Bangalore's water supply. It's not to replace Bangalore's water supply. This is very important. Bangalore had a rich tradition of protecting these lakes through community management. They had lake goddesses. There was always Gange puje at the lake when it overflowed and they

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would actually worship, they would do baagina or offering for the Gange puje, they would desilt the lakes. These were seasonal lakes you would desilt them every few years and maintain them. The faecal matter that flowed into these lakes was actually removed and sold to farmers so that it was used for agriculture. So even waste was very valuable. And there is a very fascinating little piece of information: Ronald Ross who got the Nobel Prize for his work on the discovery that malaria was caused by mosquitoes was the health officer in charge of Bangalore around 1896 or so. He actually had this fascinating description of how you should manage Bangalore to sell the filth, or the waste and he talks about the fact that European faecal matter is less valuable to farmers than Indian faecal matter. These are all the bizarre things that you hear in the archives. Waste is also managed in the British city and how you use it – everything is recycled, and this is a very different conception. But then what happens is when the Mysore Maharaja plans to take this water and pipe it into Bangalore to supplement the water supply, the British who control half of Bangalore, (the British have the cantonment, and the Mysore Maharaja has the Indian part of the city), they say why don't you give us also piped water. We'll just replace the entire city with piped water supply and in exchange we will hand-over Sampangi Lake which sits in this middle boundary, in the area that is now Cubbon Park, the Kanteerava stadium. We will give you Sampangi Lake in exchange. They actually have this exchange and that is a fundamental change in the mentality or the culture of Bangalore because once you stop depending on your local water supply, you stop valuing it completely. If they had only supplemented the water supply, and of course you needed to supplement it, instead of that they replaced it. What happens is that within three or four years we start seeing a change in the archival discussions on the documents. For instance, when there is plague in Bangalore, people start throwing corpses into the lakes and their wells also. And of course, once you have thrown a corpse into a well, you have defiled the corpse, but they have to do it because people are being pulled away into plague camps outside the city and nobody wants to go to these plague camps. Like in Covid times, everyone was terrified of being pulled away into these plague camps. If you had a dead body, you would throw it into the well because you knew your water would eventually come from piped water supplies. In a few years, Gange puje goes, local management of lakes goes, they start being called malarial cesspools, the entire discussion in the archives changes and you get to a point, (pointing to a slide in the presentation) please look at these lakes, in 1888 where you have plenty of lakes to 2015 where you have just one lake, Ulsoor lake, left in the heart of the city. Compared to the 1888 map, you can also see that Ulsoor lake is half its size. The rest has become the army area.

Trees still continued to be planted and they were planted till the 1980s and 1990s because there was a hot city and you needed shade. For instance, a number of people from Jayanagar and Koramangala will remember that when they moved into

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those newly created localities, they were tree-less, and people planted trees and nurtured them. The government would plant the trees, but people would water them with buckets during the summer and actually grow them.

But somewhere around 2007-08 as the city started expanding, all of this infrastructure expansion led to the stoppage of the value of trees. Now my map stops at 2015. What I can't show you is the trees that were cut in the past few years. Again, being data-poor, we don't have this kind of information but what you will actually see is that so many trees that have been cut, at least several lakhs. The sad part is that we don't know how many lakhs of trees have been lost. Estimates are 10-fold. Some people say we've lost to 2-3 lakh trees, others say 20 lakh trees, some people say even more. This is the tragedy, that this city is in an IT city and you don't even know how many trees you have lost to a factor of 10. We have no map of where these trees are, what was planted, what was lost, how species are changing. Not just the lakes, we lost the tradition of wells. We did a study comparing wells and lakes in the city using maps from 1885, 1935, 1973 and 2014 and we found that in the heart of the city there were originally 1450 wells in 1885, of which there were just 49 left in 2014 – and of those 49, most of them were broken down and not in use. Biome Environmental Trust and S. Vishwanath, who has been working on water sustainability for a long time in Bangalore has started a million-wells program where they go across Bangalore getting people to fund and support the restoration of wells - because Bangalore was a well-culture, every house had a well, every community had a well, every lake had a well which was serving as water sustenance for people on both sides. All of this culture has gone. Bangalore was a city of lakes, it was called Kalyana Nagar, and it has now become a city where lakes, channels, wells are uncared for, and the city keeps looking at borewells. You want Cauvery water. If Cauvery can't supply you with water, you go to Yettinahole. If Yettinahole can't supply you with enough water, you go to the Mangalore coast and have a desalination plant. Nowhere are we thinking as a city, (Biome Environmental Trust, and other individuals or groups might be doing it), but nowhere are the city planners trying to think of how we can actually make ourselves self-reliant on our own water supply. Meanwhile the city is going to grow from its 12 million-plus now to about 20 million, maybe even more. One thing that Bangalore does have is a lot of community movements and a lot of lake restoration happened because of those movements. But the other thing we don't remember is that (and this comes back to my point about lakes as places of Commons or communities to come together) these lakes were protected by communities and when we restore lakes, we are protecting them with fences. But we don't realise that there were dhobies, and there were women who foraged and there was grazing, there was fishing and other activity around the lake. If you talk to planners, they'd say, it's a modern city and you don't have place for grazers and fishers and any of these other people in this place. And so all our lakes have these

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rules: no plucking; no swimming; no fishing; no jumping into the lake; whole bunch of "No"s; not what you can do.

How were these lakes created? They were always created by local communities, not just by kings and rulers. For instance, what is a very interesting name of a lake which doesn't exist is a lake near my house is called Sulikunte. Suli, of course, in Kannada means prostitute and so you can think of the kinds of people who created these lakes. Everybody could participate in lake protection but also the kinds of sacrifices that people had to go through to collect money for charitable uses to protect these lakes. So, here's a lake that was protected in 1342 AD "for the support of animals, cattle, birds and all other living beings and the service at all times of the goddess Ganga". This is my favourite inscription and, of course, some others are more instrumental. A woman creates a lake and protects it so that her husband and other relatives for 21 generations get merit in the after-life and another man does it so that Dharma comes to his father. But the point is that they also maintained these. All of these villages had Ashwath kattes with large sacred trees which were protected, and they typically had a sisindri, which is a small water tank that is kept full of water for local communities and passersby to drink from. That was also a charitable act. We met a very interesting man near the Begur lake who was in his mid-60s, (he has passed away now) but he was paralysed, and his father used to maintain this tank. So, when he got paralysed, he actually made a vow to God that if you protect me and if you can actually restore my limbs, I will go back and maintain this sisindri. So, he got the sisindri redone and he had the photographs of his parents on both sides. And when we saw that we were curious and asked him about it. But these are the traditions everywhere – that there was always somebody in that local landscape who would maintain these lakes or water bodies or maintain the kattes or gunda thopes. And there were all kinds of motivations and curses thrown in: that a violator or anyone who spoiled this lake or destroyed it would incur the sin of having slaughtered cows and brahmins; be born as worms and vermin; and again, my truly favourite curse, will be born the husband of his own mother. So, they were really serious about these things.

They also had a very three-dimensional appreciation of nature. For instance, this is a common thing you see in several inscriptions, where you are talking about the bounds of the village which include the tank and the katte, the wet and dry lands, and they also include the wells underground and the trees over the ground. Which survey document in modern times, will ever tell you that wells are underground. The first thing we do is fill in a well and build something on it and the second thing we do is cut down the trees and build in those areas. But they had a three-dimensional appreciation of the land of the village as it wouldn't be there without the wells that give you the water underground and the trees that were there over the ground. That was as much part of the village as everything else. This is there in

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inscription after inscription. It was such a common way of doing it but it's an imagination that we have lost today. There were diverse values for ecosystems and biodiversity. The way the dhobies engaged with the lake, the way the women who foraged engaged with the lake, the way children engaged with the lake, the way the fishers, the grazers, each community had its own traditions. But many of these are changing now and, not just in the lakes, it's also the way we integrate. So that's why I am saying Bangalore culture.

Culture was always related to ecology, and this is (pointing to the slide in the presentation) KR Road which had its ficus trees on the side of the road, and this is KR Road now. The trees are gone. We interviewed the street vendors on the side of the street – the bamboo vendors. Many of you will remember that they used to be on the side of KR Road, and we would go to them to buy bamboo. They lived on the side of the road. One of the older men there was telling us about how, when the ficus trees were there, if his mother had a cold or cough, his father would cut the banyan tree, take a little bit of the sap, and mix it with the previous night's ragi mudde and she would swallow this, the first thing in the morning without water.

I've never seen this. We looked up a lot of Ayurvedic texts and didn't find any reference anywhere, but he said she never had a problem. They lived on the side of the road through rain and wind, but she never went to the doctor because this would fix a cold. Now there's nothing for them. The trees were the places for changing clothes for the women, toilets, discretionary spaces and because the trees were there, people would slow down, see the bamboo vendors, and stop for their wares. The moment you have a high-speed road people just go past, and they don't stop anywhere. So, it's a complete change in a way of life.

We did a similar study in Hyderabad with another student of mine where we were looking at street vendors. They had such intimate connections to the trees. One of them said that when my house was demolished, I lived there with my wife and child for a week. This tree means a lot to us. Another man said my father used to sell fruits under the tree and so I feel his presence when I sell fruits under the tree. Another one said he planted and watered the tree when he was a child. We found that street vendors have these intricate ways of who lays claim. If you are older and a man, you have a stronger claim on trees. Recent migrants have less claims on trees, women can't really claim the rights on trees, so they all get excluded. There is a pecking order on who gets the right to shade, and we didn't realise that shade is so important for trees. That's on streets.

What about gardens? Bangalore had the tradition of gardens with fruit and ornamental trees. Hyder and Tipu's parks that I mentioned were always ornamental gardens, and they were pleasure gardens. We didn't have a distinction. Now they are all recreational parks. With these landscapes, lots of lawns, tankers come in the summer when water is scarce, and pump out bore water. We did a study again to show that ecology has changed over time. So, the older

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parks, not just Lalbagh and Cubbon Park but Rose Garden Park or M.N. Krishna Rao Park, all of these were tree-lined parks, and they were more suited to Bangalore's ecology. Now what you have is this very landscaped parks which are sprayed, have variegated plants, don't support biodiversity, and need a lot of water. Home gardens were very biodiverse. You have creepers outside, you have avare and all kinds of soppus that you grow and now we have moved to apartments which have manicured lawns and exotic palms. Again, a lot of sprays, very little biodiversity support and very unsustainable in terms of all the inputs that you need to maintain these. Interestingly, California wanted the palms because they wanted to imitate the tropics so that's why the IT sector had palms. And then people who worked in California came back to Bangalore, and they wanted the Royal Palm-look of the IT sector in California, which is actually aping the tropics; but we are the tropics. We are not planting what works here. So, it is a very bizarre set of cultural issues that you see in terms of the way in which the city's connection to ecology also changes over time.

What we found is that there are two places where the "original" social culture of Bangalore related to plants survive. One is the informal settlements for slums, and this is thanks to my student, Divya Gopal, who studied these places, and found that informal settlements have the highest proportion of local species and useful species because they plant it for medicinal use. Local species means native species, so there is a very high biodiversity in these slums. And despite having no place, they grow them in broken pots, broken utensils, tires, buckets, paint-buckets, all kinds of places but somehow maintain them with no access to water, they are paying for these services, and they have incredible biodiversity. The second one is sacred spaces – mosques, temples, churches, graveyards – very resilient, they have ants and birds and protect roosting sites. In fact, the Muslim, Christian and Hindu graveyards on Hosur Road have incredible biodiversity. If you can get to some of these places then you can actually sample a very high biodiversity, which we were fortunate to do. But none of this is recognised as you protect these lakes and parks and other landscapes today because they tend to simplify them. Ecology is valued now in terms of monetary value. Ecological economics, an entire discipline has come around that, but it completely forgets the fact that you need to have the multidimensional way in which people value this. Lakes and parks and street trees have what we call ecosystem-provisioning services which are important for mental and physical health, spiritual and sacred needs and very important for the poor. So, we did a study, for instance, which talked about how does Bangalore actually protect its lakes and what do they mean for a city of migrants. I was talking about the fact that Bangalore is going to grow and there are lot of these environmental refugees, and often what people ask me is, is this a lament of a city lost, you know, of Commons lost. That the migrants are coming in, it's no longer possible to save these lakes and of course they are all

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going to disappear. We looked at three lakes in south-east Bangalore where I live, which were restored, and looked at the visitors who come to the lakes. And we found that if you are a migrant community, you can actually develop a very strong sense of place or environmental place-making because the lake is there. There was a mother of a differently-abled child, there were corporate employees who used to come there to drink tea, there were transgender community people who said that we sit at the lake because the lake doesn't judge us, and there was this group of people, environmental refugees from Raichur, north Karnataka, who were actually at the time of the survey taking ₹1000 less income to work at the lake because they didn't want their son to be exposed to a hazardous environment. If they went to a construction site, they would get paid more money, but he would not to be able to grow up in a healthy environment. We found that when people come to these lakes, they see a bird or a tree or something else which reminds them of the place they came from (and they have commons in their places and Community Action) and then they start to meet other people and then get involved with waste management, and traffic management, and with local government schools and other social movements spring up from this. So, a lake is a place for this kind of place-making for migrants. So that's why restoration has much more in terms of spillover benefits, not just what it does for the region, but what it does to make the people who come and feel part of the city, feel that it's their city.

Even restoration is not enough in itself. One of the studies we did very recently is, we looked at eBird data. A lot of naturalists in Bangalore use eBird as an app and collect data on birds. We looked at that and tried to see what happens to urbanisation and how does it restore and protect lakes in cities. So, across Bangalore you have a lot of lake movements which have restored lakes and what we find is that resident bird ecology increases. That's really nice. Resident bird populations actually increased a lot in Bangalore over the last few years because of lake protection. But migratory birds don't, and that comes back to my original point of cities being interconnected to the entire landscape. Migratory birds are coming from the Himalayas across this landscape, which is getting spoilt over time as there is so much destruction along the way that they are not even able to reach Bangalore. So, it is important to not only protect the ecology of the city but also to think of how it is connected to all the ecosystems around and to see how Bangalore can contribute to the area around in terms of trying to restore its ecology so that hopefully all the other kinds of bird species can come back.

What can Bangalore do differently? We have cut down lakhs of trees and we are facing climate and climate change and urban heat island effects. So, we are going to have a city that is going to be hotter, drier, more floods, more unliveable. And the IPCC report says that India is going to be extremely vulnerable to climate change. We did an analysis of city adaptation plans across India and what we found was that most of these

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plans are tech-focused, (coming back to the smart-city idea) and they have almost no use of nature as nature-based solutions, almost no discussion of stakeholder participation, almost no discussion of equitable solutions for the poor or finding solutions for migrants. It's things like Ahmedabad heat action plan which is very successful. It is all about SMS alerts for the poor to say get out to safe places. But there is no restoration of lakes in Ahmedabad, or planting of trees, or making it a cooler city for people to live in. We found in our research that trees have a huge effect on microclimate and air pollution. Trees reduce air pollution substantially and clean the air. They also reduce air temperature by 30-50 C and road surface asphalt temperature by 150-250 C making it a much cooler and liveable city. And these are trees on the sides of streets and where are most of the trees in Bangalore being cut? Along the sides of streets. And the plan is not to plant them back because if you see interviews that policy makers have given to newspapers, they say that if we widen a road and we cut the trees, we are not going to plant trees on the side of the same roads because when we have to widen the roads again, activists will protest. So, you have to think of how this entire thing gets framed – that these roads will be infinitely widened, and there will always be activists to protest so let's just not have the trees on the side of the road. But where is the pollution on the side of the road and where is the heat on the side of the road? That's the place that you actually need the trees and Bangalore is being a place that is losing all its trees in the highways, the side of the roads, everywhere, you know. The city was famous as a Garden City, not for its parks so much but for its tree-lined streets. The city is actually a very good place to study because not just our own work which has now been there for a long time but there are many institutions in Bangalore which have also studied it and have a lot of information. So, in terms of the Global South, it is one of the best studied cities. Yet we find that when you are trying to plan how to manage the city it's such a tech-focused approach, and not looking at ecology and how we can make the city ecologically smart. Now I will come back to the work that we are doing in other cities in Karnataka. This is a few years ago just when the smart cities program was launched in Karnataka, and we interviewed city-managers who are dealing with a smart-city program. In most cases they said they had not been consulted while drawing up these smart city plans. But we asked them, what will you use the smart city money for, and they said, we have to first fix potholes, pipes that are coming apart, and missing sanitation and sewerage lines – that's where I need to put the money. They are not thinking of smart tech. They are thinking of the fact that they are so under-provisioned that they don't have money for basic services. So, when the smart-city money came in, they would use it to fix basic services. One of the places where we were working was in Mangalore, and the consultant group that was actually supposed to come up with the smart-city plan came in at that point, with a plan which is not climate-resilient, which is not bolstering nature, restoring the mangroves, and protecting nature.

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Because these are not home-grown solutions, they are not going to fit contexts where they are not grown. Not that technology cannot be used. Technology has a role to play in smart cities. I want to make that clear. Obviously, it's very useful because you can be smarter about your energy management, for instance, or water management but to use that without paying attention to the ecology, which is really the low-cost solution will not be sound. The lowest cost solution is that ecology will work free for you and that is what we need to be doing – using ecological wisdom. So how do we build a pluralistic, polycentric vision of ecological sustainability by keeping communities and ecology at the center. What we are trying to do is to build up outreach. We have to work with art, education and outreach and imaginations because a lot of this is about ecology as I wanted to show you that the deep history of Bangalore will tell you that the city has grown with its ecology. But we need to restore that imagination and keep the city growing with its ecology. These are some of the various things we have been doing – children's books. This is one of my favourites, Where have all our gunda thopes gone? We did this bilingual book in Kannada and English and then the Karnataka government asked for a print copy. So, 6400 print copies are in panchayat libraries across the state, and we have a little booklet that goes along with it which can be used as a teacher's aid to get children out into the gunda thopes and learning so that they can protect this. And now the government is trying to see if you can use MNREGA funds to actually restore gunda thopes across the state.

So, these are the kinds of connections I think we need to be doing to transform some of this research into action.

A quick recap: nature in cities is essential for sustainability, resilience, and also ecological justice. But there is a lot to investigate, we've barely scratched the surface. The story of Bangalore is a fascinating story of the city that survived through the centuries because it paid attention to its nature and its culture and we can't take our current pattern of ecologically foolish growth for granted. We need to make Bangalore, an ecologically smart city, otherwise it's not going to be climate resilient. We have a new book coming out in another 3-4 weeks, Shades of Blue: Connecting the Drops in India's Cities which like Cities and Canopies talks about urban issues (note: Shades of Blue has since been published and is now available). We discuss issues of water because, I think, water is the biggest challenge that Indian cities are going to face under climate change. How do we connect the drops of imagination, of culture, of ecology, of economy in India's cities. Speaking of imagination, I also write a 1920s fiction series – The Bangalore Detectives Club – which is very important for me because it draws from my nostalgia for the old Bangalore and I think a lot of this discussion is of a city which was open to different kinds of people, which was embracing of diversity, of differences, of pluralism, of culture that thrived around its ecology.

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# About the speaker:

Professor Harini Nagendra also leads Azim Premji University's Center for Climate Change and Sustainability. Over the past 30 years, she has been at the leading edge of research, examining conservation in forests and cities of South Asia from the perspective of both landscape ecology and social justice. For her interdisciplinary research and practice, she has received a number of awards including the 2009 Cozzarelli Prize from the US National Academy of Sciences, the 2013 Elinor Ostrom Senior Scholar award and the 2017 Clarivate Web of Science award. Her publications include the books, 'Nature in the City: Bengaluru in the Past, Present and Future' and 'Cities and Canopies: The Tree Book of Indian Cities', as well as the forthcoming book, 'Shades of Blue: Connecting the Drops in India's Cities' and over 150 research publications including recent papers in Nature, Nature Sustainability and Science. She writes a monthly column titled: 'The Green Goblin' for Deccan Herald, and is a well-known public speaker and writer on issues of urban sustainability in India. She also writes a mystery series set in 1920s Bangalore, 'The Bangalore Detectives Club'.

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