

## Chapter 1: Understanding Urban Systems

Today we will talk about cities as systems of systems and explore various city sub-systems. Cities can be seen as a particular type of socio-ecological system or SES in short. SES's are made up of 3 interacting domains: **the social, the ecological, and the economic**. There is a continuous set of flows and interactions between these subsystems. Each city has embedded within it multiple complex systems such as land, transportation, environmental services like water, sanitation and solid waste, housing, education and health care. Each is different with complexities of its own. However, most have some common attributes. Stocks of people, assets, ecological and financial resources flow within the subsystems and between them. In short, cities have an entire metabolism like the human body and often more complex as they have both natural and human made parts.

To take an example, water is an important ecosystem service that a river or a groundwater aquifer below a city can provide. Groundwater may be extracted from a natural aquifer and after it is treated, delivered through pipes to households at a cost. The price of this water may be set high to help reduce waste and incentivize households to invest in water recycling. Both the cost and the price are determined by the economic system. Because the poor may have no water or toilets, they defecate in the open creating a health risk that seeps into the groundwater. This not only makes them sick because their vendor provides untreated groundwater but contaminates the aquifer which then impacts better off households in the city. They then start paying more for medication to address episodes of severe diarrheal disease.

For a city to become sustainable, we have to understand this complex chain of cause and effect that flows through each of its subsystems - the social, the economic and ecological. Instead of treating the symptoms which is a common practice across the world, for example, in this case, by trying to force poor people out of the city or setting up treatment systems in each middleclass household, it is more sustainable to find the root causes of the problem and find systemic solutions to them. One such solution would be to provide universal water supply and sanitation to all residents in the city and setting an affordable lifeline tariff to ensure that the system works for everybody and monitoring the quality of both ground and drinking water to ensure that nobody gets ill. The savings in health expenditure and losses in employment to the poor people who fall ill may often be more than the cost of these measures. As we can see from this highly simplified example, cities are socio-ecological systems have interdependent and dynamic sub-systems. The interaction between the parts is often in flux, creating counterintuitive behavior that's difficult to address unless one takes a holistic or a whole systems view. This is not easy but if done can deliver long lasting, cost effective and often sustainable results.

How can this be done? One immediate challenge is that of governance. The functioning of typical local governments is organized around a 20th century imagination that sees cities and countries not as systems of systems but as a set of functional sectors. The SDG's for the first time in decades provide us a global opportunity for an integrated joint up action around sustainable cities. The challenge of integrated development is simultaneous delivery across all

these subsystems and goals. Because cities are at a smaller scale compared to countries and because of the need to deliver all these outcomes at a local level, cities have a natural advantage when trying to address sustainability solutions.

Another challenge is that SES's across the world have been in a process of transition. A transition from agrarian or biomass economies in many low income countries of Asia and Africa through fossil fuel driven or industrial economies like China, to information and service sector led economies in most high income countries. Each are characterized by different levels of material, energy and information throughput, levels of human development and hence performance on the SDG's. Not all areas in a country or territory make this transition at the same time. This is an important constraint to urban sustainability as cities cannot be separated from the regions in which they are located. Urban centers in regions of significant agricultural surplus like market towns and cities such as Chicago in the 19th century have a very different material and energy metabolism. There are largely service sector in information driven city such as Bangalore which will need to import and pay for much of its food, ecological services and often industrial products. The sustainability transition of one city even within the SDG frame could be very different from another. Since sustainable cities are always situated in regions, both city and region, need to make a joint transition. Therefore, we need to take a territorial approach to sustainable cities that link city and regional initiatives.

As cities grow in size up to a particular limit, the cost of provision of networked infrastructure and services reduces dramatically because of the economies of scale. These agglomeration economies in water supply and sanitation, for example, or health and education provision make it easier and cheaper to provide services to larger and denser concentration of people who live in cities than in lots of dispersed villages or hamlets. Similarly, internet connectivity allows urban areas to exhibit a significant increase in productivity and value addition both in economic and social capital terms because of the ability to learn, share knowledge and common infrastructure. This can lead to geographic clustering, development of corridors and other similar urban or regional patterns of development. One such example is the north east corridor in the United States that takes us from Boston down to New York, Pennsylvania and Washington DC creating an almost continuous hub of industry, innovation and services. To create such clusters, we need to think holistically about space and the territorial development of sustainable cities. The challenge of implementation is that a wide range of institutions and stakeholders need to be brought together. This demands a new set of strategies and processes where multi stakeholder engagement and democratic participation become a rule rather than an exception. The process of participative budgeting in cities, for example, that now extends over 1700 cities across the world is just the beginning of this process.

Can the SDG's actually enable transformative change in the contemporary world? In a seminal paper, the famous environmental scientist, Donella Meadows suggests that there are many leverage points within a complex system like a city, where a small shift could enable significant change. Altering indicator systems for the SDG is an important way of changing system feedback and the structure of information flows. Changing SDG targets is the way of changing

the rules of the system and by making commitment of inclusion like leaving no person behind or no place behind, changes the power relationships behind the rules effecting significant systemic change. The real power lies in changing the system goals like the United Nation's political process of defining the SDG's that can have a very powerful influence on system behaviour. This is the real importance of having an urban SDG, goal 11 and its connection with all the other goals. The only more powerful instruments are changing mindsets and going beyond existing paradigms which, of course, are the basis of the revolutions that underpinned the socio-ecological transitions that we are talking about. History will tell whether the urban SDG's mark an important milestone in this transition to a new sustainable paradigm.