INDIAN INSTITUTE OF TECHNOLOGY MADRAS

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ECOLOGY AND ENVIRONMENT

Sustainable Water Management

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SUSTAINABLE WATER MANAGEMENT IN URBAN AREAS (Part B)

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Principles of IWM

Implementation of Programs

Establish mechanisms and policies which enable long term support.

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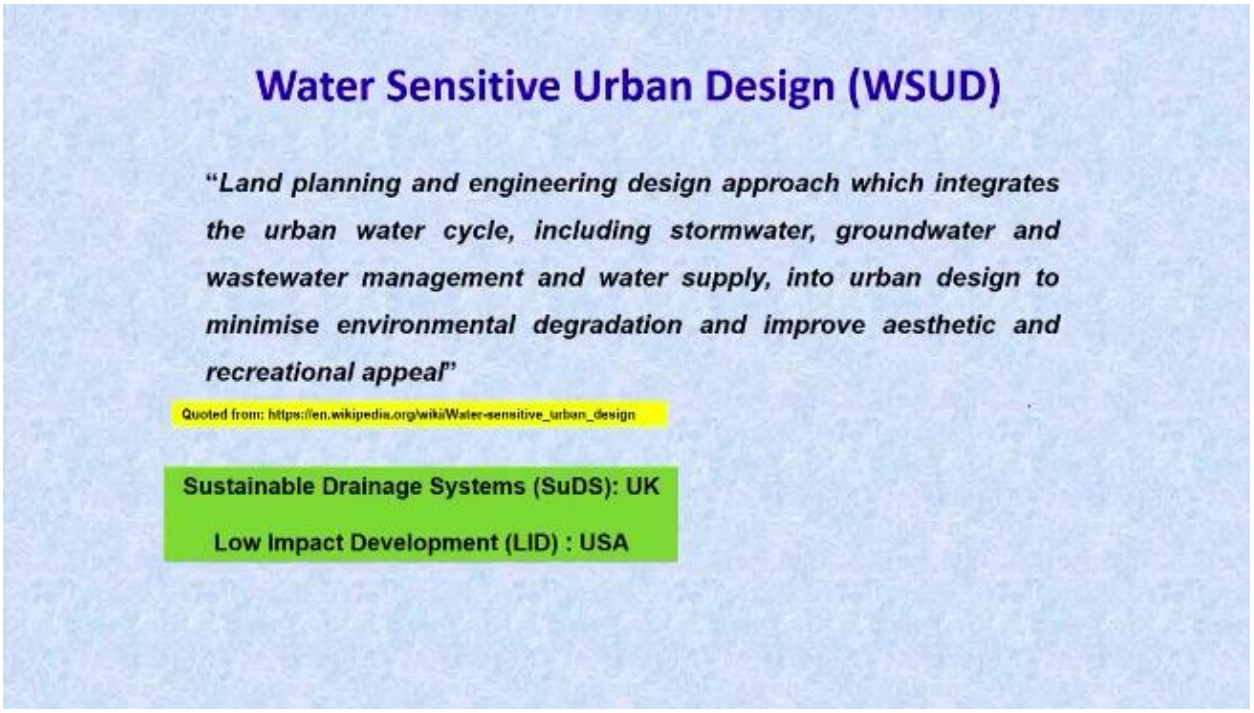
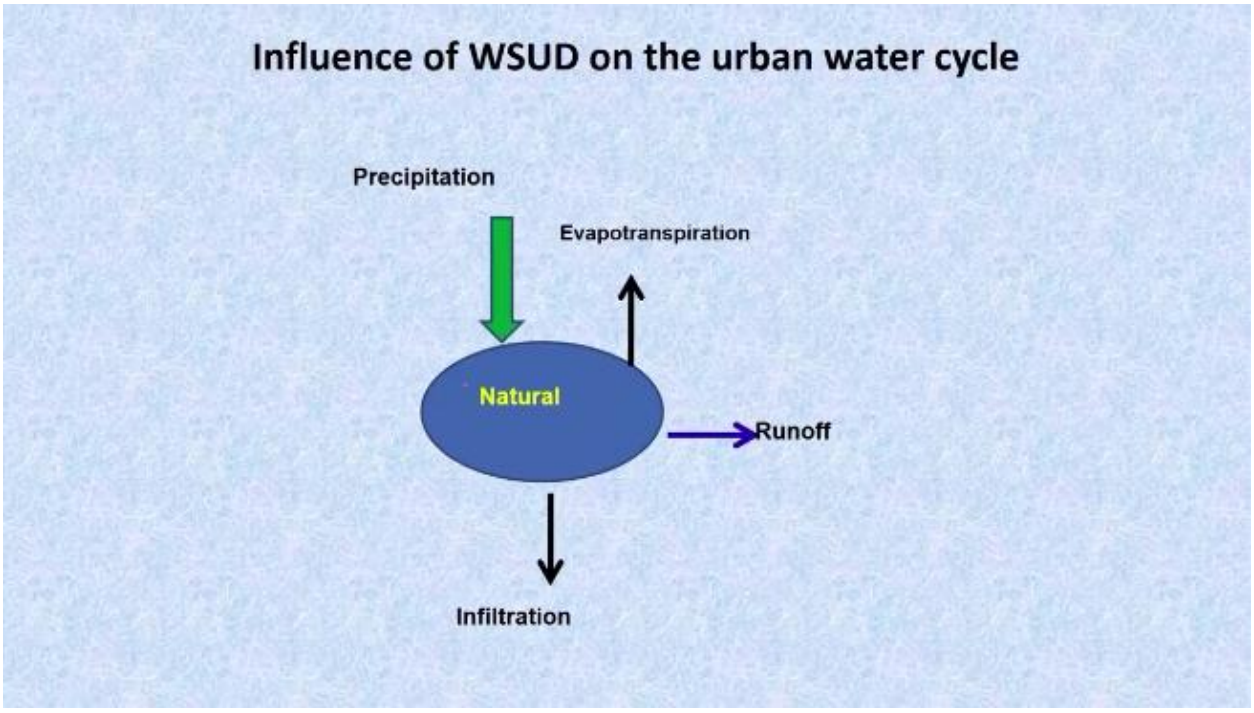
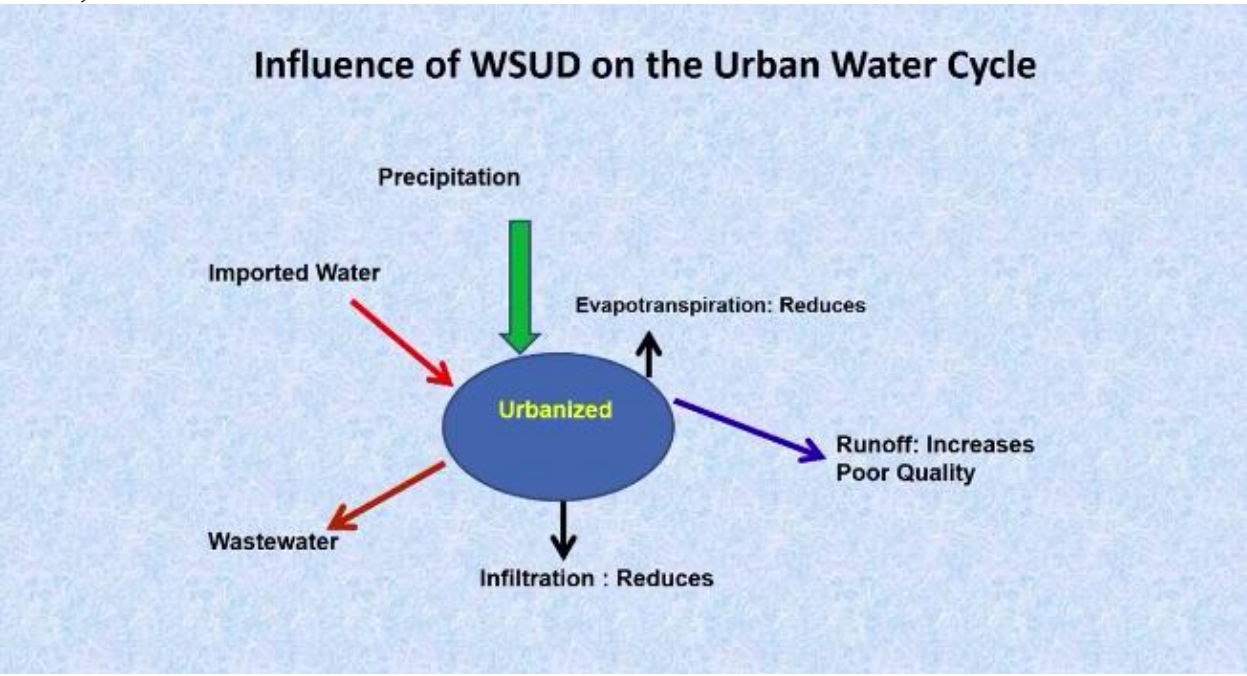
We have to establish mechanisms and policies which enable long-term support, that means whatever we are doing, we need to take our policymakers, legislatures, and people representative into confidence, so that we get a support of the long-term support and policies are framed accordingly, very, very important when you talk about the sustainable water management in urban areas.



In this context, I would touch upon the water sensitive urban design concept, WSUD. Quote from; it is given in the Wikipedia. I am quoting from that; it is land planning and engineering design approach which integrates the urban water cycle, including stormwater, groundwater and wastewater management, and water supply. Please note that it integrates the urban water cycle including stormwater, groundwater, and wastewater management and water supply into the urban design to minimize environmental degradation and improve aesthetic and recreational appeal. This idea has been there for quite some time, and it is catching up in, and it is catching up all over the world.



In fact, the same thing is known as sustainable drainage systems, SUDS in the UK, and then low impact development in the United States. Just to give you an idea of what this water sensitive urban design is all about, we would like to discuss the influence of water sensitive urban design on the urban water cycle. You consider a natural system where urbanization has not taken place, in that area, the water input is through precipitation, it is a rain. When the rain falls on the ground some of that water will go into the ground through the process of infiltration and some water from that area, eventually get evaporated from the water bodies or transpired through vegetation, this is what we call evapotranspiration. So, that water gets back to the atmosphere through evapotranspiration process; this is the basic water cycle that we all know. And then the balance will flow on the ground in the form of overland flow or stream flow or river flow, that is what we call runoff. And there is a balance between the precipitation, evapotranspiration, infiltration, and runoff; this is for a natural location.

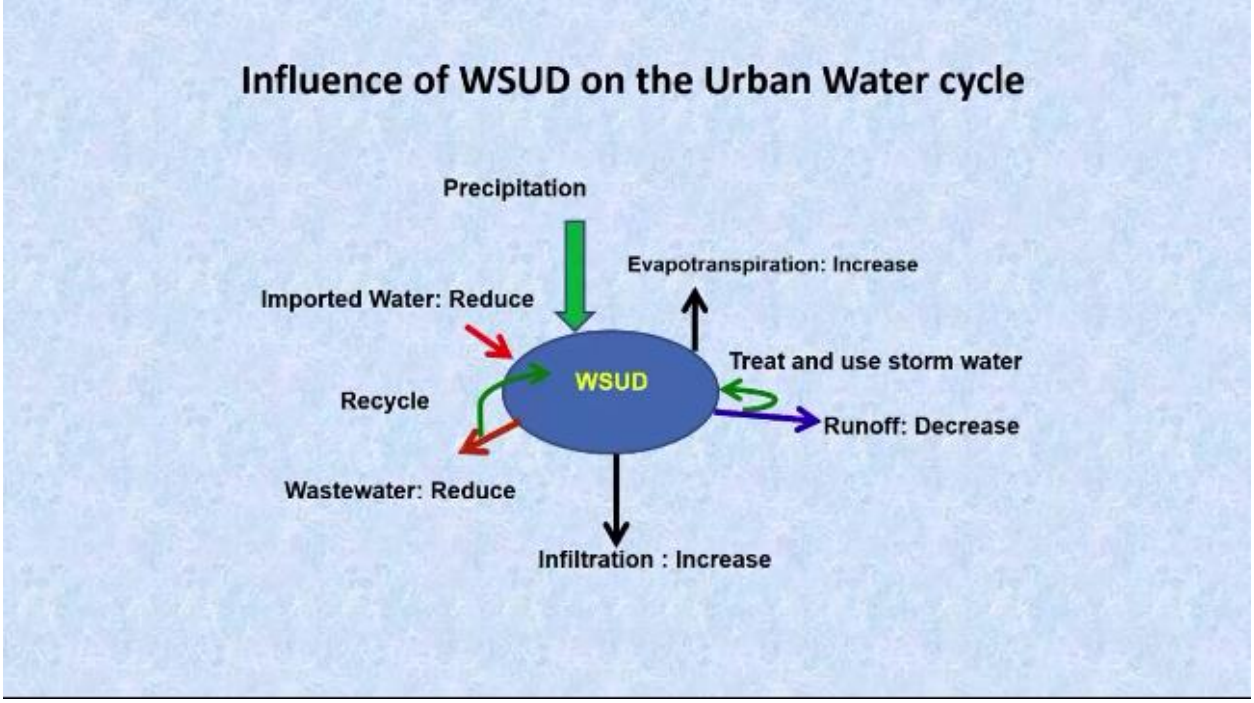


Now, we do urbanization of that area, let us say precipitation is same, precipitation is same but then because of urbanization, let us say a lot of areas got paved and that interferes with infiltration, there is not as much infiltration as earlier. So, the infiltration reduces, we also might have cut lot of trees, and then we do not have many water bodies as many water bodies as earlier, because of that we reduce the evapotranspiration.

And because of that, there will be a lot of flow balance, because of water balance, there is a lot of flow in the rivers, in the streams. So, there is a runoff; there is an increase in the runoff, not only there is an increase in the runoff, this runoff, also because of urbanization can become poor-quality water. If you are not doing our waste management properly, then definitely whatever the water that is flowing in the rivers and streams will be of poor quality, that is what urbanization has done.

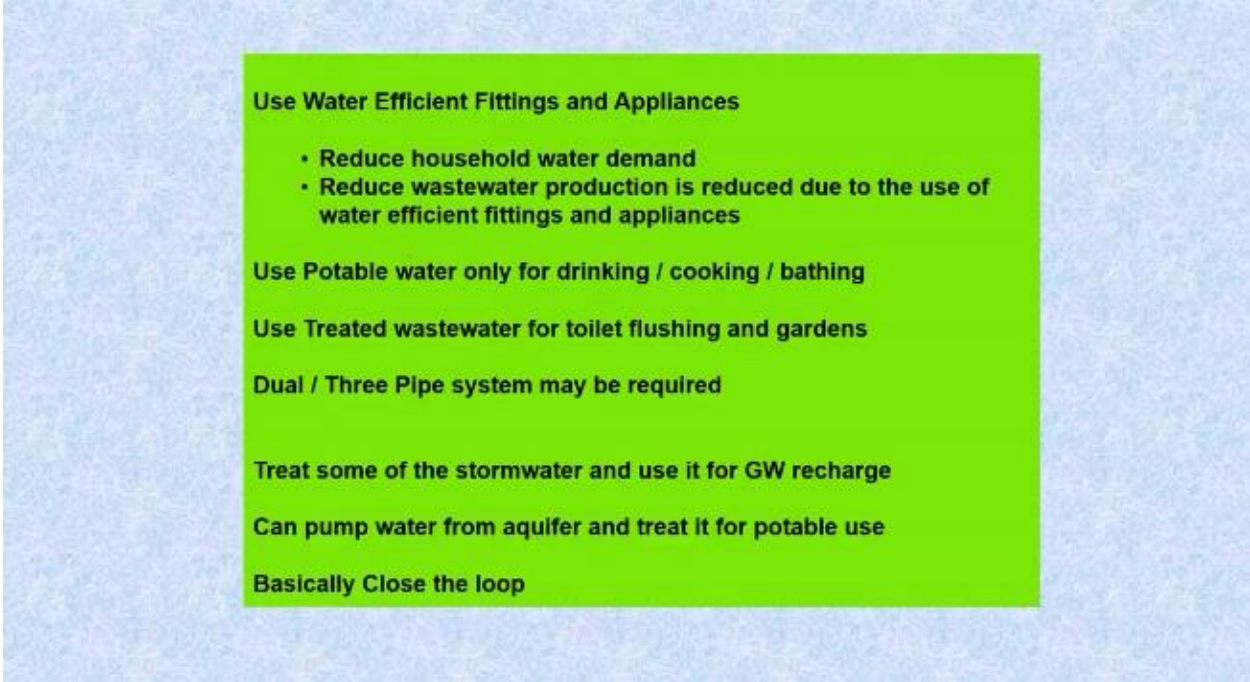
Another thing the urbanization has done is, we would generate a lot of wastewater. And because there is more demand for water now due to urbanization and water may not be available, we will import water from outside. So, this is how urbanization would affect the water cycle. And this is

not that good. So, in water sensitive urban design what we do is, we find ways of treating this wastewater and then put it back into the area where it got generated.



So, we recycle and reuse this treated wastewater, for example, we can treat the wastewater and then use it for flushing our toilets or use it for you know horticulture or gardening and so on and so forth. And then we also, when we do the developments, we do not pave the entire surface with concrete, we go in for concepts like porous parking places or our channels, we will not line our channels with concrete. We do the development in such a way that we do not interfere with the infiltration process significantly. So, we can increase the infiltration by not, I mean by doing this low impact development processes.

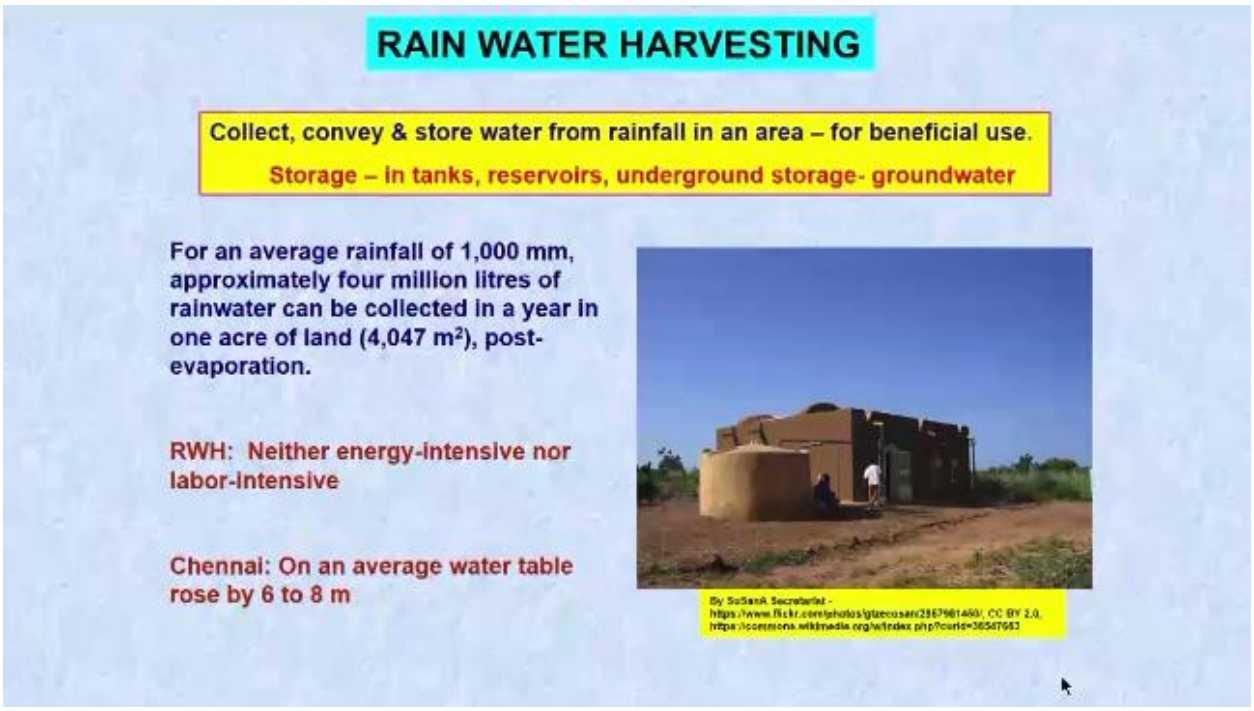
Another important thing is we can interfere with the runoff, the stormflow or stormwater, we can capture some of this stormwater and then we can treat and then use it back in our area, like rainwater harvesting if we do. And since we also do not cut many trees, as many trees as we would do in conventional urbanization, we will also increase evapotranspiration. Because we are treating the wastewater and then we are sending it back, the amount of wastewater that is discharged into water bodies or going into the ground that will reduce. So, that will reduce the pollution, and the net effect is we may not have to import as much of water as we do earlier, so we can reduce the imported water.



So, we use water efficient fittings and appliances to reduce household water demand. We reduce wastewater production due to the use of water efficient fittings and appliances. We use potable water only for drinking, cooking and bathing whereas we use treated wastewater for toilet flushing and gardens.

You all have seen a single pipe systems, plumbing in your houses, but now we are going for a dual piping system which carries different quality water for different purposes in the houses, or we may even go for a three-pipe system. Although the capital cost of the systems could be high, but still the amount of saving that you do on the freshwater demand is significant, and we should go in for this kind of a systems, dual piping systems.

We treat some of the stormwater, we should not capture the entire stormwater because the stormwater has to also go to the downstream areas, people need water there, you cannot capture entire stormwater. But some of the stormwater we can capture, treat it and then use it for groundwater recharge. That way we will be able to increase the water level in the groundwater, and we can pump that water later on and treat it for potable use. Basically, we have to close the loop at local levels, that is the concept of water sensitive urban design.



I will discuss briefly about rainwater harvesting. Rainwater harvesting involves collection, conveyance, and storage of water from rainfall in an area for beneficial use. The rainwater can be stored in tanks or ponds or reservoirs or can be used for recharging the groundwater or I will call underground storage.

The experience in city of Chennai has shown that for an average rainfall of 1000mm, approximately 4 million liters of rainwater can be collected in a year in one acre or 4047 meter square of area, this is post evaporation. One advantage about rainwater harvesting is it is neither energy intensive nor labor intensive. And in Chennai, it has been estimated that the water table rose by 6 to 8 meters after introduction of rainwater harvesting. I will show some, few pictures of rainwater harvesting.

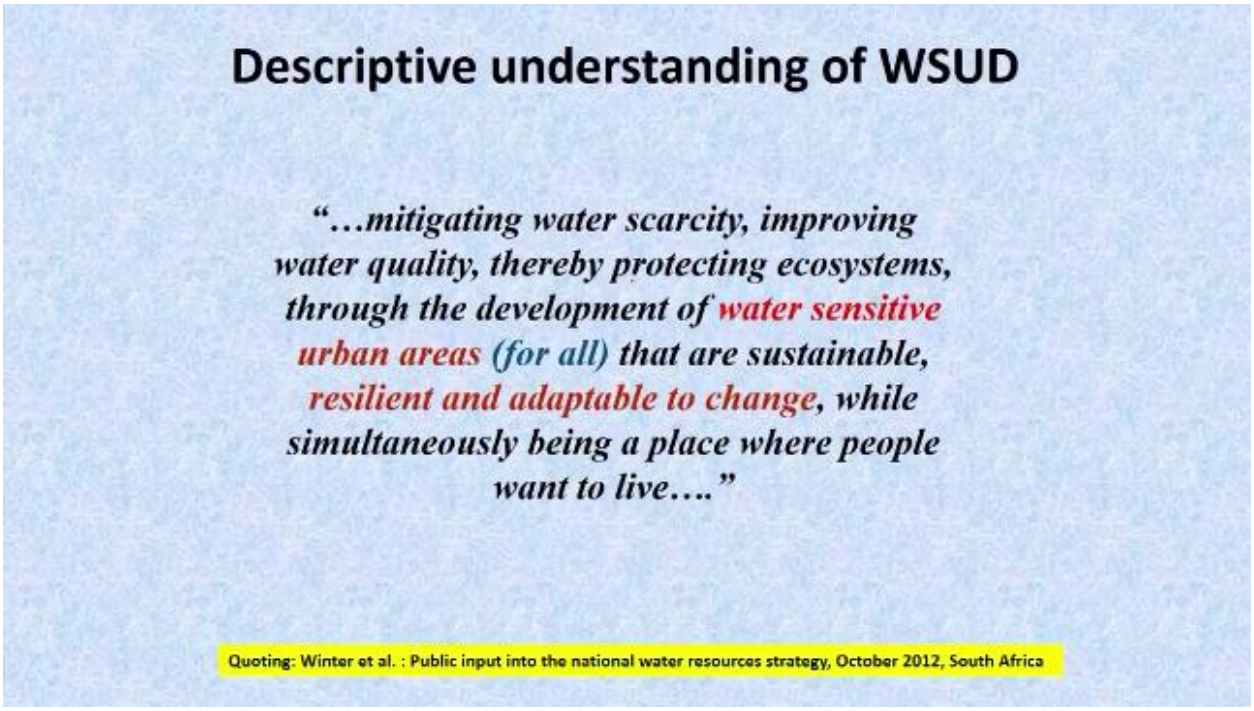
By Nimit Kumar Makkar - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=21718243

By Spiritualfade (talk) 09:37, 23 July 2009 (UTC) - I took this pictureTransferred from en.wikipedia, Public Domain, https://commons.wikimedia.org/w/index.php?curid=10784933

This is a picture from traditional rainwater harvesting that was being carried out in Rajasthan in arid region in North Western part of India. This is like a water is collected and then sent to a small well there. There is another traditional rainwater harvesting structure; this is also being used in state of Rajasthan you can see how the water goes and then goes into the tank and then there is a cover and then it gets stored in the tank.

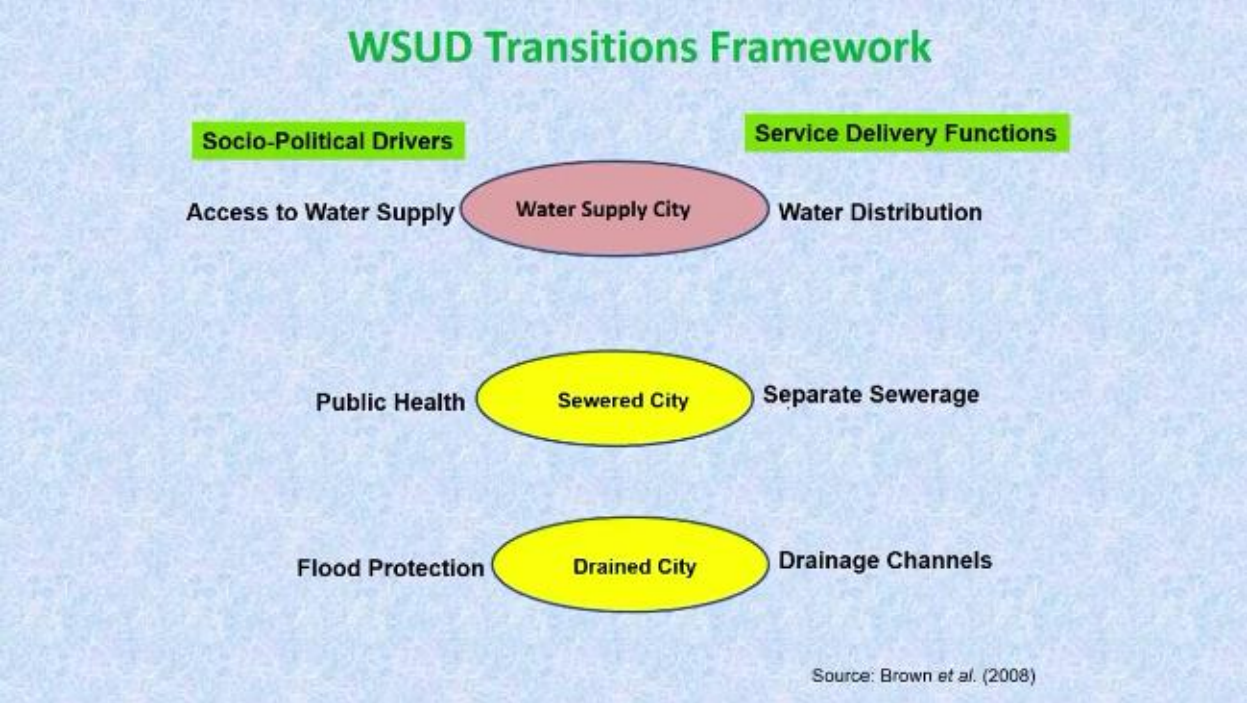
By Sumita Roy Dutta - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=65066956

As I mentioned rainwater harvesting can be done in agricultural areas too, here we have shown how there is a pond which is created there on the hill slope which can capture lot of water, and it can be used later on for either irrigation or any other purpose.



Now, to summarize we would like to have a descriptive understanding of water sensitive urban design. It is mitigating water scarcity, improving water quality, thereby protecting ecosystems, through the development of water sensitive, here the word water sensitive is the paradigm shift in terms of urban planning. So, whatever we do we are sensitive to water in that area either in terms of water supply or drainage system or flood protection or eco-services and so on and so forth. In urban areas when we say urban areas, what we mean is not only residential, but it includes commercial and industrial. For all, this means it includes all types of users and adoption of fit for use type of quality of the water like we do not really need to have very high quality of water for our flushing systems. So this, for all, indicates that kind of a concept that are sustainable, resilient and adaptable to change, when we say adaptable to change, a resilient which means the system should bounce back if there is any you know disaster, let us say right after the disaster, the system should not go out of service completely, it should be able to bounce back and again the system should consider the effects of impending climate change.

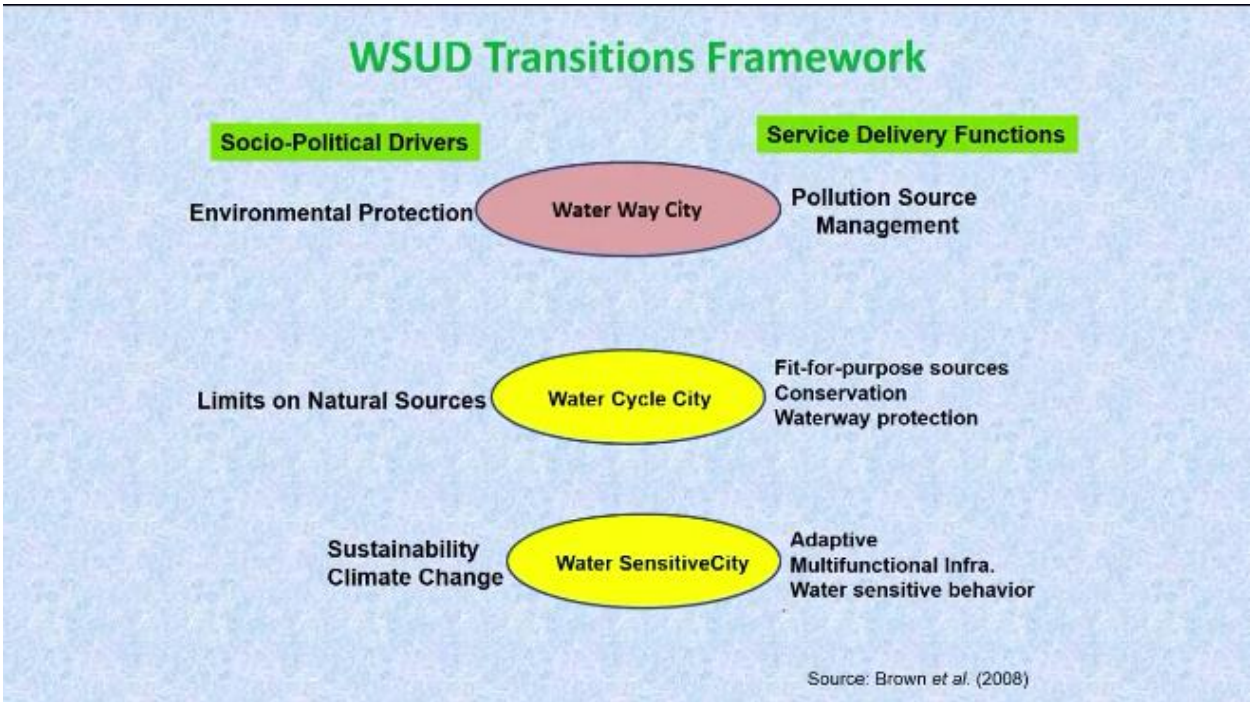
Now, while simultaneously being a place where people want to live. In fact, people should be having comfortably, I mean living in that location, they should be proud of that particular place, so where they are willing to live. So, this is the descriptive understanding of water sensitive urban design.



There is a transition framework for this water sensitive urban design, is the is the final step in terms of the development in an area. Here on this side, we have socio-political drivers, the drivers which are resulting in the change and what we get in terms of service delivery functions on this side. In an urban area, first evolves as a water supply city because people would like to have access to water all the time. So, we design water distribution systems, we worry about the hydraulics of the flow, and then we make sure that we supply enough water at the required pressure.

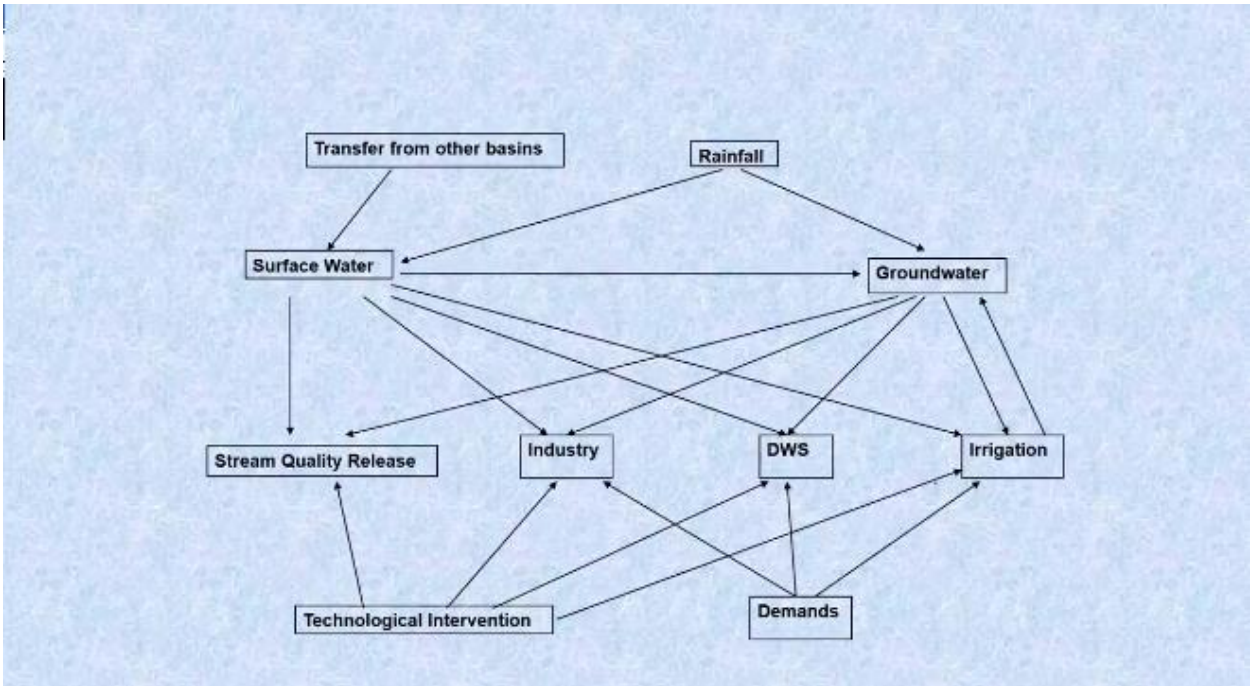
This then evolves to including water supply city, it includes that, but then it also now includes what we call a sewered city. The driver for that is the public health, public health issues, so we cannot just leave waste water on to the open areas or into the rivers or ponds or whatever, because that may have an adverse impact on public health. So, sewered cities will evolve, where we will be providing a separate sewerage system. Like these days, I mean in India also many, many towns which did not have underground drainage systems, we are all providing the underground drainage system for that, a separate sewerage system.

The next, it evolves to a drained city because during the rainy season if the excess water is not managed properly then we will have floods and flood damages. So, we have to take care of this flood protection, and this drives the city to become a drained city which means that we will be providing stormwater drainage systems, and then how to make sure that this floodwater recedes fast and then there is no damage due to the floods.



Next, it evolves to what we call a waterway city. The driver for this is the environmental protection, we care for our environment, so we want to protect that, so this basically involves the management of pollution at the source. Let us say we have a river or a lake and then we want to protect it from pollution, we may intercept the water, the wastewater that is going into the water body, we may intercept and then put a small decentralized wastewater treatment plant, so that the particular water body is not polluted, this is what we call water way city. This then evolves into a water cycle city, the driver for that is there is always a constraint or limit on the availability of natural sources, that is a driver. So, we evolve to a water cycle city, here is where we bring in the concepts for fit-for-purpose sources, dual piping system, conservation of water, probably leak detection, I mean leak management and waterway protection and so on.

This then evolves into a water sensitive city. Basically the driver for that is caring for the future. We would like to preserve our resources for future generation, or what we call intergenerational equity. And we also are aware of the effect of climate change. So, these are the drivers which will push the cities to evolve into water sensitive cities. Basically the water sensitive cities are adaptive, resilient, and the system has multifunctional infrastructure and the people who live, their behavior is also a water sensitive behavior. So, this is the transition framework for water sensitive urban design.



Finally, I would like to summarize that we have multiple uses for water. We need some water for stream water, I mean stream quality, maintenance of stream quality, we need to leave some water in the river. This slide, I had shown it earlier in one of my lectures, and I am just showing it again. There is a stream quality release, water is needed for running the industries, this is domestic water supply, and we need water for agriculture or irrigation. And this water can be supplied either through surface sources or groundwater sources and these surface sources and groundwater sources they get the recharge from the rainfall or sometimes we also by transfer of water from some other basin, that is the import of water from other basins. And so all these are interconnected, and again the demand for the industry or the demand for stream water quality maintenance or the demand for you know irrigation or the demand for drinking water supply they can be controlled through demand management. And the demand also may come down because of technological interventions. So, all these are interconnected, and there should be a plan for and then operated or integrated manner through water sensitive urban design, okay. With this, I end this lecture.

Thank you.