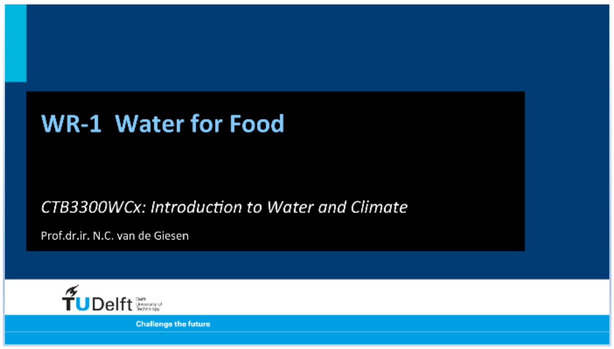
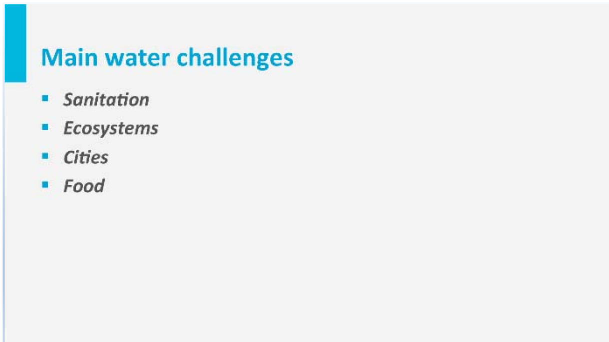
CTB3300WCx – Introduction to Water and Climate

WR1 – Water for food

Nick van de Giesen



Hello, my name is Nick van de Giesen, I am professor of water resources management. Now, humanity faces several water challenges that need to be tackled within the coming generation.



There is the continuing water and sanitation crisis, restoring and maintaining healthy aquatic ecosystems, and supplying the ever thirsty cities with sufficient water. The most chronic challenge, however, is the water for food challenge: How will we find enough water to produce the food that we need in the coming thirty to forty years?

In 2050 there will be nine billion people to feed instead of the seven billion people today. Increasing prosperity will further increase demand for food. In the coming 40 years, humanity will have to produce as much food as it has produced over the past 8000 years! Presently, 70% of all water that we extract for human usage is used to grow crops and raise cattle. In many places around the world, extraction of water for agriculture is under pressure from competing high value usages such as industrial and urban development. We also want to protect our aquatic ecosystems, which further limits extraction for agricultural use. This holds especially for those areas where irrigated agriculture is most developed: North America, South and South-East Asia, and Australia. In these areas, the amount of water available for agriculture will only decrease.

In a nutshell

In 2050

- *40% - 80% more food*
- *With 10% less water*

In a nutshell, the challenge is to increase food production in 2050 by 40% to 80% with 10% less water than we use for food now.

Individual water needs (modest lifestyle)

Drinking water	*1*	*m^3/year*
Kitchen	*5*	*m^3/year*
Laundry	*10*	*m^3/year*
Toilet	*20*	*m^3/year*
Industry	*200*	*m^3/year*
Food (vegetarian)	*500*	*m^3/year*

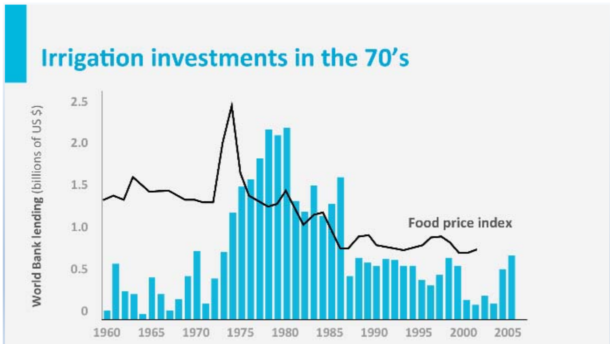
So how much water does one need? Per day we need to drink about three liters, or one cubic meter per year. This is not very much. So when we hear about droughts and people dying because of droughts, it is normally not because they do not have enough water to drink. Of course water quality is always an issue, which tends to become more acute in times of drought. For cooking, washing our food and pans, we need another 5 m^3/year, again not a very large amount. For washing our bodies and clothes, we need 10 m^3/year. Water quality for washing needs to be reasonable but not as high as for drinking water. Flushing toilets more or less doubles the water we need in and around households. There are important differences around the world of course, with rural areas in developing countries using about 40 liters per day per person and urbanized America about 200 liters per day. Again, the quantity of household water is rarely an issue but quality is. We really see a big step when we look at how much water is needed to produce the industrial goods that we use. About 200 m^3/yr is needed to produce the industrial goods that we consume. Again, there are important gradients across the globe because of differences in consumption patterns but 200 m^3/yr is a good ballpark figure. The real jump comes from the water we need for our food. It takes over 1000 liters (or kilograms) of water to produce one kilogram of edible food. That means that even if we have a modest vegetarian diet, the amount of water needed for food dwarves the amount of water needed for other purposes.

Individual water needs (demanding lifestyle)

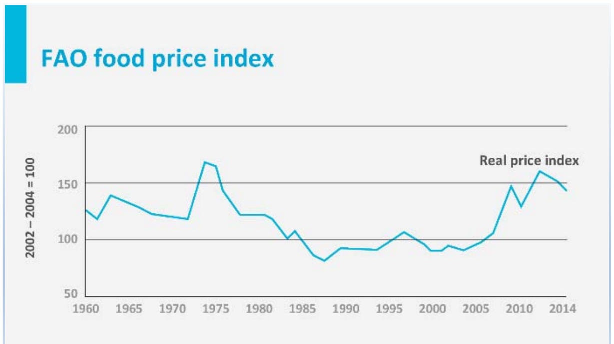
Drinking water	*1*	*m^3/year*
Kitchen	*5*	*m^3/year*
Laundry	*10*	*m^3/year*
Toilet	*20*	*m^3/year*
Industry	*200*	*m^3/year*
Food (vegetarian)	*500*	*m^3/year*
Meat (extra)	*500 – 1000*	*m^3/year*
Biofuels (1000 l)	*1000*	*m^3/year*

If we gear up our lifestyles, and it is expected that we all will improve our material wellbeing over the next generation, the amount of water needed rapidly increases. This is due to the fact that poor people are, generally, by necessity, near-vegetarians. I grew up in a relatively money-poor family in the relatively rich Netherlands and we would not eat meat every day, simply due to lack of financial resources. People really tend to eat more meat when their incomes improve. Animals are typically fed by vegetation that needs water to grow. Because we only consume the net production of meat, this takes a lot of water. And even in a country like India, with a vegetarian diet preference, we see a clear increase in the consumption of dairy products with increasing incomes. Partially, the increase in water consumption through animal products are misleading in areas where grass is the main feed and not enough rainfall is available to grow other crops. Still, we do not exaggerate when we say that the water needed to produce our food doubles when we add animal products to our diet.

Biofuel is an interesting renewable alternative to fossil fuels. If, however, we would all decide to drive a car on biofuels, using about 1000 liters of fuel per year, we would almost again double the water needed to produce all the agricultural good that we consume. Biofuels for cars may not be very likely but for airplanes, biofuels seem the only carbon neutral alternative for decades to come. An intercontinental return flight takes about 300 liters of fuel per seat. Biofuels and bioplastics will add considerably to the total amount of water we need per person in 2050.

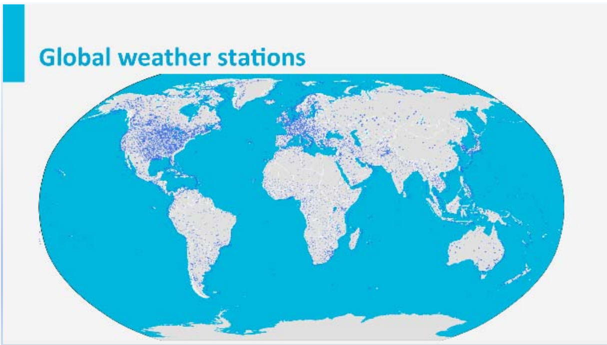


So how can we increase our food production? In the past, especially during the 1970's, we were able to avoid mass starvation by the introduction of high yielding varieties of, especially, wheat and rice. These improved varieties needed also increased inputs in the form of fertilizers and water. This graph shows how food scarcity drove up food prices, which, in turn, triggered large investments in irrigation development. These investments clearly dropped following the drop in food prices and my graduation as irrigation engineer in 1986.



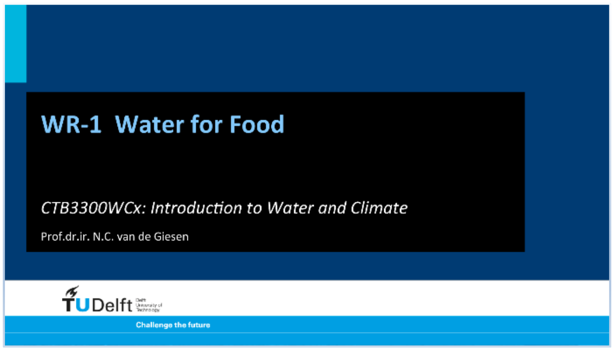
We see that over the past five years, food prices in real terms, that is, inflation adjusted, are again as high as they were in the 1970's. It should be understood that the supply elasticity of food is low: One cannot simply increase acreages or productivities because land and water are limited resources. So it stands to reason that we will again see an increase in investments in irrigation.

The final question then becomes: where we will grow all that food. This map from National Geographic shows production, of cereal production, around the world with green showing high yielding areas and pale yellow low yielding areas. When you look at the map, first leave out all areas that do not have enough water: North Africa, Middle East, Central Asia, East China, Central Australia, Western part of North America. Europe and North America are already producing at relatively high levels. The same holds for South, Southeast, and East Asia. Actually, in these areas agriculture stands under high pressure from urban and industrial development, especially when it comes to water. That leaves two major areas where food production can expand and where space, soils, and climate are reasonably favorable. These are the savanna areas around the Amazon basin and the savanna area around the Congo basin. Africa and South America are the only areas with the space and water resources to expand food production by 40% or more, over the coming decades.



To expand food production in these areas without over-stretching the available water resources will be a major challenge indeed. For starters, we have very little data from these areas. This map clearly shows that in Africa and South America we have much less meteorological stations than elsewhere. To fill these gaps is a true scientific challenge. That we need to face.

Finally, we need the investments. Large scale irrigation has important social and environmental implications. Irrigation development over the past decades in Africa has shown mixed success. Small scale, village level irrigation schemes, like this one in Ghana, tend to be better managed than larger schemes. The issue is that it is difficult to see how we can scale up such schemes. Presently, only about 2% of sub-Saharan agriculture is irrigated. To turn South America and Africa into the bread baskets of the world will be a truly global challenge.



Thank you for your attention, next time, Dr. Marie-claire ten Veldhuis will explain why we also need a lot of water for the city.