Future Chapter?: Water

- Water Balance

Water Balance

The Water Balance

(source https://www.alevelgeography.com/water-balance/)

The balance between inputs and outputs is known as the water balance or budget. The water balance can be shown using the formula:

precipitation (P) = streamflow (Q) + evapotranspiration (E) +/- changes in storage (S)

P=Q+E +/- S

The water balance affects how much water is stored in a system. The general water balance in the UK shows seasonal patterns. In wet seasons precipitation is greater than evapotranspiration which creates a water surplus. Ground stores fill with water which results in increased surface runoff, higher discharge and higher river levels. This means there is a positive water balance. In drier seasons evapotranspiration exceeds precipitation. As plants absorb water ground stores are depleted. The is a water deficit at the end of a dry season.

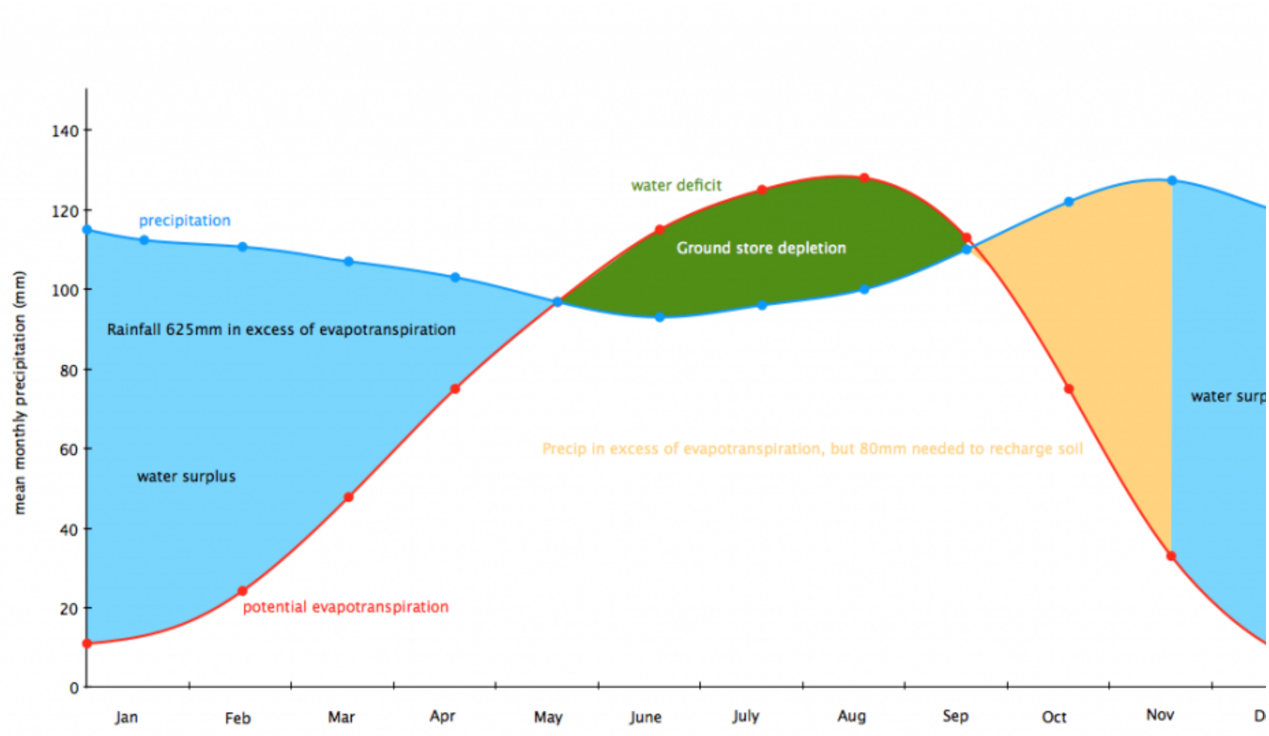

Figure 1. Model of the water budget in a drainage basin

The balance of the water cycle

(source Water for the Recovery of the Climate: A New Water Paradigm p18-20

Authors: M. Kravcík, J. Pokorný, J. Kohutiar, M. Kovác, E. Tóth)

The expression "water balance" is understood in hydrology to be a relation which characterizes the circulation of water in a certain system, mainly in a watershed or in its parts. We express it with equations, which show the relationship between elements entering a system (for example, precipitation) and elements leaving a system (for example, evaporation and surface or underground runoff). A third, neglected element exists between the entry and runoff of water and that is the change in the volume of water in a system.

Monitoring the water balance of a territory is one of the basic tasks of hydrology and meteorology. Such monitoring consists predominantly of regularly measuring total precipitation and flow rates of water in watercourses through a network of precipitation measuring stations and limnographic stations for selected profiles of watercourses, particularly during their outfall to larger basins, to the waters of neighboring states and to the seas or oceans. In the scope of a meteorological and climatological network, attention is paid, in addition to these parameters of water balance, to the temperatures in a territory, levels of groundwater and the quality of the water.

Workers from professional institutes subsequently process data obtained from long-term measurement into a long-term series which helps them monitor the current development and trends of the measured quantities.

On the basis of different models and results of known data, they create models for the development of these quantities with an eye on the future. Climatology is dedicated to such modeling. A common area for us is perhaps the most well-known modeling of the development of weather by meteorologists, although their models are built on a different principle. A forecasting service is able, with reasonable accuracy, to model weather one, two, three, even ten days in advance.

Climatologists, however, model the development of a climate a number of years or even decades in advance.

A necessary, though not sufficient condition for a stable climate in a territory is a stable water cycle (Fig. 2).

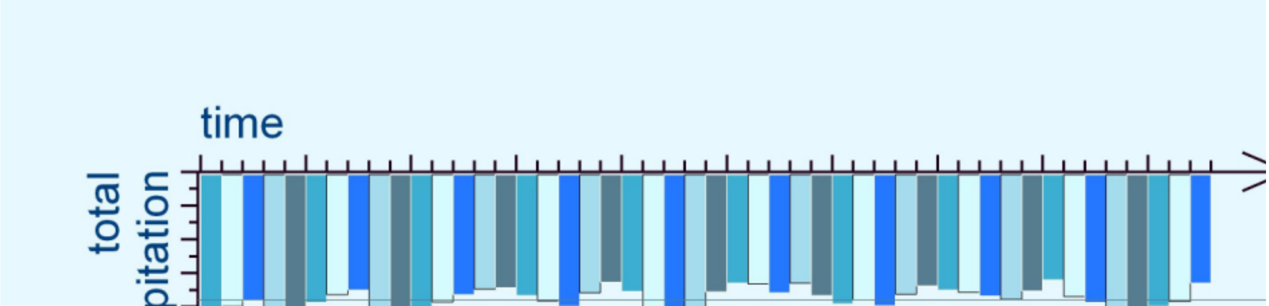

Fig. 2 **Diagram of the long-term stable water cycle on land**

That's why a very important piece of information, which should be the primary purpose for monitoring the water balance, is the difference between the amount of water which enters into a system and the amount of water which exits from a system. This difference, when positive, indicates to us the addition of water to a system (saturation), and when negative, the loss of water from a system (dehydration).

Most models of weather or climate don't really provide this information, however,because they do not calculate it or they do not consider it significant.

Amongst both the general public and experts the established notion prevails that this difference is, for large units (such as river basins or whole continents) and for long periods of time (a year or more), equal to zero, or around zero. The conviction that the amount of rain the wind brings from the sea is the same amount of water that flows in rivers to the seas is a legacy of the times when hydrologists first discovered the water cycle. They thus explained an old puzzle: how it is possible that the levels of the seas and oceans do not rise when all the rivers of the world constantly flow into them. Today, however, hydrological measurement shows that the levels of the seas and oceans are rising and at the same time the levels of groundwater are

falling, and yet it doesn't seem to have occurred to anyone that the balance between the inflowing and outflowing water cannot be zero. The great danger of neglect threatens just when this difference is very small and yet still on the same side of the equation. In such a case it can lead to the drying of a country over whole decades without hydrologists ever noticing the reason for it.

Within the scope of hydrology, meteorology and climatology, the water balance of a state and the water balance of the main watersheds in the framework of the state have so far only been monitored on the level of individual countries. The bigger the system, the easier it is to overlook the dangerous one-sided deviation mentioned in the previous paragraph.

The New Water Paradigm

(source Water for the Recovery of the Climate: A New Water Paradigm p.67-71

Authors: M. Kravcík, J. Pokorný, J. Kohutiar, M. Kovác, E. Tóth)

The new water paradigm must learn from the mistakes of the old paradigm. In our opinion, among the biggest mistakes of the old paradigm is that water was perceived as an isolated entity, water’s interaction in the framework of the whole ecosystem being neglected, particularly water hidden from view (water in soil, in the atmosphere, in plants). The paradigm also neglected the synergic effect of introducing even minor measures to regulate the state and circulation of water in a country. Readers who did not begin reading this publication at this chapter but who have also read the previous chapters, know what kind of measures and what impacts we have in mind. The old paradigm considers water as a fixed given renewable resource which is subordinate to deviations in the global climate, or is even its "toy," but which itself has no noticeable influence on the global climate. The circulation of water, according to the old water paradigm, was rarely influenced by human activities and if it were, then only marginally and indirectly, via the influence of other parameters which supposedly had a larger impact on the global climate than water. The blindness of the old paradigm to climatic impacts of water management

measures is furthermore crowned by its ignorance and denial of the importance of the small water cycle. Given the current level (lack) of knowledge, we can hardly wonder that water managers and all other people who come into contact with water issues, are neglecting the importance of the water balance on all levels, manage it badly and are especially destructive in their treatment of the small water cycle.

In the new water paradigm, the water balance at all levels—on the territory of individual communities, within cities, in forests, on agricultural land—is the central theme. The new water paradigm warns that unlike the issue of global warming, the issue of the drying of the continents, or substantial parts of them, is receiving very little public or scientific attention. The drying and subsequent warming of the continents causes an acceleration of natural processes following a certain specific pattern and interdependance. The drying is caused by urbanization with its rapid sluicing away of rainwater to the seas and oceans, by agricultural activities and by the deforestation of ever larger areas of the Earth's surface. This drying creates "hot plates" with a complete chain reaction: the warming of continents, the destabilization of the water cycle and an increase in extreme weather. This is causing extensive damage to both economies and civilization. That's why calculating, systematic monitoring, guarding and maintaining equilibrium in water balances is becoming imperative even on the city level. Thus far in its history, however, mankind has not even considered this condition for sustainable economic and civilizational growth.

The new paradigm, though, not only calculates the balance of water but also offers a solution for making up the deficit. We can return the lost water back to the continents by keeping rainwater on a massive scale in the places where it falls, particularly in those areas where the influence of human activity is causing a drying out. Just as the impact of human activities (as their unplanned secondary effect) can lead to a breakdown in the small water cycle, so concerted human activity can contribute to its renewal over land as well as to securing long-term stability in the water balance of a territory with sufficient water resources. If the current method of managing rainwater and surface water on land is turned around and the conservation of rainwater and surface water on land is ensured by a system of all embracing measures for increasing the water-holding ability of an entire watershed (which are often identical with anti-erosion measures); and if only the surplus surface water is sluiced away from an area, then with each turn of the cycle there will be recovery of the small water cycle, the reserves of groundwater will gradually improve, the volume of precipitation will increase, and extreme weather events will decrease.

Mankind has used different means of rainwater harvesting and water conservation over the millennia in order to obtain sufficient water resources. Our knowledge of their broader impact on the stabilizing of the water cycle and climate is often primarily intuitive—it was never described from the scientific standpoint. Traditional systems for obtaining water in the 20th century were founded on the building of reservoirs in which water was collected and which served to balance the water regime of rivers. This water was subsequently used to supply the population and to serve the needs of industry and the production of energy and food. In our case, however, the goal is to collect rainwater and, wherever possible, return it to the small water cycle. The primary principle is to allow infiltration of water into the soil, its saturation and the creation of groundwater reserves as well as surface water reserves, and thereby foster the growth of vegetation, which works as a climatization valve between the soil and the atmosphere. The capacity of soil (and subsoil) is usually much higher than the volume of the largest artificial reservoirs in a country.

The process of saturation of the small water cycle should be repeated so long as the hydrological regime of watersheds are out of balance. However, such measures need to be carried out on a massive scale.

Leaving untreated great "hot plates" lowers the effectiveness of measures taken in their nearby surroundings and sometimes even directly threatens them. The measures that need to be taken are simple, effective and cheap but need to be implemented in the territory of each community and town. Wherever possible, all the communities in the world should get involved in this program of rainwater harvesting and conservation on the continents.

Rainwater harvesting and the conservation of water on land has a number of aspects which on first view can appear to be paradoxical.

People fearing floods can mistakenly expect that a dry country can better absorb a great amount of water than a country which is already significantly saturated with water. Experiments and experience show otherwise, however. Water flows over sunburned land as if over impermeable plastic foil while water infiltrates into healthy soil, held firm by vegetation, as if into a sponge. What's more, moderate temperature differences on the surface of land covered with healthy vegetation do not induce the torrential type of precipitation which occurs in an overheated, dehydrated landscape.

One paradox, then, is that water itself is the best protection against water. Another apparent paradox is that, despite what many people might think, the method of conserving rainwater in one area does not deprive neighboring lands downstream of precious water. The difference is similar to that between a static command economy and a developing free economy. The first always divides the same small cake, and a larger piece for one means a smaller piece for the other. The second, however, divides a cake which is always growing for the benefit of all. The conservation of rainwater on land actually helps neighboring lands.

The runoff of rainwater from a country is not stopped completely but is merely slowed down. In place of the sudden rain-dictated, often extremely small or extremely large flow rates, particularly from surface runoff, a much more balanced runoff, fed from groundwater, can now be passed on to one’s neighbors. Moderate rain from the small water cycle rooted in a water-saturated country moistens the cities, fields and forests of neighboring lands and thus opens up the opportunity for these places to manage water in the same way. The method of retaining rainwater on land creates cascades of watersheds (or their parts) rich in water instead of dry cascades of watersheds.

The new water paradigm means developing, utilizing and supporting overland rainwater harvesting and conserving rainwater in watersheds so that ecosystems can "produce" enough good quality water for humanity, food and nature, can purify polluted water, can reduce the risk of natural disasters like floods, droughts and fires, can stabilize the climate and strengthen biodiversity and can become a component of economically sustainable development programs. What the new water paradigm offers is promotion and support for such a culture of land use which will permanently renew water in the water cycle through saturation of the soil with rainwater. The new water paradigm means a return to a natural responsibility for the state of water in one’s region, but can also bring a new dimension of solidarity and tolerance between people and communities in watersheds.

The new water paradigm brings with it a lot of exceptionally good news. The new economy of water promises that it will be able to balance the debt that arose in the past, lower the unwanted effects of this debt manifesting themselves in ever more extreme weather, stabilize the management of water and guarantee its sufficiency.

The continents, with harvested rainwater, will stabilize thermally and climatically and the extremes in the weather - particularly floods and drought - will be mitigated. Increasing the water-holding capacity of the land and harvesting precipitation in the places where it falls are themselves effective anti-flood measures. Natural disasters will obviously always occur, but excluding external factors, the level of economic and civilization damage caused by the weather will be greatly reduced. These statements also apply to the possible revival of semideserts and deserts through rainwater. With these areas we can assume an exceptionally long and difficult process, because the evaporated water, given the thermal differences, will be carried away to other regions. Nevertheless, particularly in those cases where the change was unwittingly caused by man, deliberate, carefully planned human activity can perhaps return them to their previous state. The slow and gradual revival of semideserts and deserts through rainwater, particularly in places where just a relatively short time ago civilizations blossomed, should not therefore be impossible.

This thinking represents both an exciting challenge and a program of activity at the same time. Just as our ancestors attempted in their battle with nature to stake out a piece of uncultivated land and civilize it, so must we attempt to recover from the ocean the water we all have lost in the struggle, so that the efforts of our ancestors to civilize our planet were not merely in vain. We can begin with relatively small volumes of water, like collecting rainwater for the dried-out lawn in our front yards. From there we should go on to the much larger task of finding a way to regain the water which once existed on the territory of cities and which, since the times of the industrial revolution, has been running out into the oceans. The largest, and in a country like Slovakia the maximally taxing, requirement would be to recover all thewater which exi sted in the ecosystem at the time of the climax forest that covered the land a thousand years ago. On other territories, the challenge would have to go even further; for example, we would like to return water and renew the water cycle in the Mediterranean or on the once fertile lands of the Fertile Crescent.