Independent Council for Ecosystem Restoration (ICER)

Submission to Federal Government

Requested by Regen Action

Title:	**A better and more cost- effective solution to the proposed $2+ Billion raising of the Warragamba Dam Wall.**
Cabinet / Committee:	For the consideration of PM & Cabinet / Treasury / Climate Change, Energy, the Environment and Water
Date of Submission:	13th March 2023

Relationship to previous decisions:

ICER has recommended a **VETO** of the mooted NSW Government policy to raise the Warragamba Dam wall, at a cost of $2+ billion, ostensibly to mitigate future flood damage and risk to life.

This is not a cost-effective solution compared with a far cheaper proposed land management alternative.

Priority: **<u>HIGH</u>**

Financial Impact: **YES** – A $1+ billion **cost saving benefit** for Australian taxpayers

Legislative change: **NO** – Using proven, simple landscape science understanding will save taxpayer dollars and achieve a much better, and more permanent outcome.

Submission type: This is a private submission made by a group of concerned scientists, land management & sustainable agriculture experts.

At a recent summit meeting held in Berrima NSW, 100% of the 25 attendees gave their endorsement to request a feasibility study be conducted into this alternative solution to raising the Warragamba Dam wall.

Summit attendees included:

- NSW Government Member for Goulburn, Wendy Tuckerman
- NSW Government Member for Wollondilly, Nathaniel Smith.
- Gundungurra (First Nations) people
- Independent Council for Ecosystem Restoration (www.ICER.org.au) scientists and directors.
- RegenAction (NFP regeneration organisation) Chair and executives.
- Goulburn / Mulwaree Landcare Chair
- Experienced Regeneration practitioners
- High profile community leaders and advocates for a Warragamba solution that delivers the most cost-effective solution.

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1 Recommendation(s)

(1) It is recommended that Federal Government:

VETO the proposed expenditure on raising the Warragamba dam wall, by 14m, estimated at a cost $2+ billion plus the cost of EIS compensation.

ICER, Regen Action and all summit participants recommend that NSW Government conduct a full scientific evaluation and feasibility study into the proposed alternative solution using world best-practice science. Consider attachment 1 (Kravcik Global Action Plan).

(2) ICER further recommends that urgent consideration be given to:

The responsibility of the NSW Government to suitably **investigate** any option that is recommended by current best-practice Science and is also fiscally the best outcome. This can be simply resolved by DPIE providing the funding and resources necessary to work in open collaboration with the Regeneration community to evaluate the alternative solution to the dam wall raising. Science shows this alternative of regeneration can achieve superior flood, fire and drought mitigation as well as far-reaching economic, environmental, and cultural benefits.

The alternative proposal is to implement a broad-scale land/water regeneration of an estimated 900,000 Ha of Warragamba catchment. If this was to occur, it would see a significant **retention** of water in the soil regolith. The Science community can demonstrate that damaging flood waters would be absorbed, diminished and slowed. Water retention in the landscape would also makes it more resilient to droughts and bushfires. Additionally, there is a significant benefit in the enhanced quality of potable water and in water security in the long term for the Greater Sydney population.

A regeneration of the catchment also has the potential for carbon sequestration to be included in the financial model. An estimate in the vicinity of 6 – 7 million tonnes of carbon sequestered in an estimated 5 years, @ 1% Carbon increase per annum.

2 Purpose of the Submission

To alert Government that an environmental land management solution exists that is significantly better and more cost-effective in flood mitigation and flood damage prevention than raising the Warragamba dam wall. We ask that at the very least, an Independent Review Panel of Government and land management experts consider the benefits of this alternative land management solution, that ICER respectfully submits.

3 Proposal

ICER propose that an environmental land management solution exists that is a cheaper and more effective alternative to the huge cost and environmental destruction that would be caused by the raising of the dam wall. This alternative solution has not been adequately considered, if at all, in Government expert assessments of the best flood mitigation fix.

Warragamba Dam currently has an operating capacity of 2027GL. The NSW Government is proposing to raise the Warragamba dam wall by 14 metres to increase capacity by approx. 10% - 200 GL - to mitigate downstream flooding. The cost is likely to be more than $2 billion.

There are significant political risks arising from the environmental damage that will inevitably be caused by the wall raising. If the wall is raised, substantial new portions of the catchment will be permanently inundated, including parts of the World Heritage and important indigenous cultural sites. These impacts will potentially threaten the World Heritage status of the Blue Mountains.

But environmental concerns are not the primary focus of this submission. This submission details how the $2+billion wall raising proposal is a needless waste of taxpayer's money.

The currently favoured wall raising proposal is based on the understanding from WaterNSW that '…*no mitigation measures can achieve the same risk reduction*' [1].

This submission sets out the science to demonstrate why this conclusion should be reconsidered; that the proposed wall raising is based on debatable scientific assumptions and outdated water management paradigms and that solid peer-reviewed science should demonstrate that there is a <u>proven</u> viable alternative.

In 1848, Count Paul Strezelecki, the Polish explorer who first selected Warragamba catchment as the source of Sydney's water, published research (see attachment No.4 reference) which showed historically that NSW soils contained at the time, on average, soil carbon levels of between 7-9% and upwards of 16-18% in wetland systems. Poor land management since has reduced most of NSW's soil carbon levels to less than 1%.

This is a crisis for NSW because it is soil-organic carbon (SOC) that holds water in the land-scape. Carbon is the sponge that holds water in soil. A 1-gram increase in SOC will hold an extra 5-8 ml of water. When looking at this across the catchment, an increase of 1% in SOC over 1 Hectare = would increase soil water holding capacity by 177,000litres. So, that across the entire Sydney water Catchment, this would mean an extra 4000GL of fresh water held in the regolith. The proposed dam wall increase will only give the dam an increased capacity of 200GL. Restoration of the Catchment to previous historical soil carbon levels of 7-9% could see additional system capacity increase to levels not seen since the early days of Settlement.

> Warragamba Catchment receives an average annual rainfall of 840mm. Over the entire 900,000 Ha Catchment this equates to 7560GL of rainfall, 75% of which flows out to the sea annually.
>
> Should the Warragamba catchment be restored to historical soil carbon levels, then the resulting regolith WATER storage capacity increases exponentially:
>
> 1. By raising the catchments SOC from its current 1%, 2% would deliver **4000 GL** of extra water holding capacity in the regolith.
> 2. By raising SOC back to historical levels of 7-9%, this would see water holding capacity increase by a staggering **28,000 – 36,000GL**, an order of magnitude 18X the current dam capacity.

What is indisputably proven on solid science is that what will fix Warragamba Dam's flood risk problem permanently is a solution that increases BOTH soil carbon and soil water holding capacity in the catchment landscape.

We submit for your consideration that this Solution can be achieved for a fraction of the dam wall raising cost – somewhere in the estimated range of $450-500m of that proposed $2+billion budget.

It would also make Australia and NSW potential world leaders in fixing one of the greatest environmental problems of this era.

The principles used in this land management technique, are known variously as 'Nature Based Solutions', 'Natural Sequence Farming' and form part of what ICER Scientist, Dr Michal Kravcik calls the 'NEW Water Paradigm'. They primarily focus on rebuilding soil organic carbon levels by slowing water flow thus re-coupling the water and carbon cycles over the landscape. They are a proven environmental land management technology that has been scientifically validated on multiple occasions to have beneficially transformed farmland across Australia, the USA, Europe and Asia. (See attachment 1. Kravcik Global Action Plan)

ICER's Proposal would follow the principles of this Nature Based Solution. This is done by reversing the damage caused by heavy grazing of stream-bed banks following European settlement, which has, mainly by reducing vegetation, significantly increased stream velocities. European farming techniques on NSW's landscape has resulted in gouging of stream-beds and the lowering of water tables in floodplains. These negative changes to the landscape are evident throughout the Warragamba catchment area.

These same negative changes to the landscape have caused dry spells to turn into drought conditions faster than they should; biodiversity being reduced, and in many instances fresh water that once sat on top of saline water being drained off, resulting in salt being released into the stream-bed. It also increased the likelihood of catastrophic flooding in the catchment area because the loss of carbon in the landscape meant less water was held by the lesser proportion of soil organic carbon.

The fundamental, proven principle behind this technique is that the health of floodplains and their stream-beds, can be significantly restored by slowing the rate of water flow, especially after rain events, by a series of physical interventions in the landscape. This is achieved by using a naturalised series of 'leaky weirs' of rocks, sediment, trees, branches, reeds and grass roots mimicking the original natural slowing impediments to flows.

The proposed land regeneration technique uses small secondary diversion channels (Contours) to reconnect streams to their floodplains. These channels braid out through the lush meadows to the edges of the floodplain and water then returns to the main stream through surface and sub-surface flows. They pick up peak flows that are diverted by the leaky weirs which maintain normal base flow to downstream properties.

During high flows, as water spreads across the floodplain in braided diversion channels, water is absorbed through floodplain Runnels, that are raised, sandy intake beds, which connect and then recharges the fresh groundwater lens sitting above the saline groundwater layers and just below the plant root systems. What this means for the Warragamba catchment is the ability to store vastly more potable water for dry times than is currently possible with the dam lake.

[1] https://www.waternsw.com.au/projects/warragamba-dam-raising

4 Strategic merit

Will the proposal contribute to a Priority target?	**<u>YES</u>** Regeneration of the Warragamba Dam catchment landscape will be a permanent fix for the urgently needed flood mitigation priority. It will also save considerable taxpayer dollars for other urgent projects, and it will underline Australia's commitment to solid environmental credentials.

5 Consultation

In formulating this submission, consultation was undertaken with ICER expert Scientists and with consideration given to the Global Action Plan and Civic Protocol documents as presented in attachments 1&2. ICER propose that any future considerations be undertaken with guidance from these documents and offer their services, expertise and advice as part of an open and transparent evaluation.

Future evaluation should involve the participation of all stakeholders, including the NSW Government and ICER, as well as representatives from the conservation and academic communities, to review the scientific evidence and economic feasibility of each proposal.

This evaluation should include a comprehensive assessment of the potential environmental and economic impacts of each proposal, as well as a thorough analysis of the potential risks and benefits associated with each.

The evaluation should also consider other relevant factors such as the potential for long-term sustainability, the potential for technological innovation, and the potential for public-private partnerships to support the restoration efforts. Once the evaluation is complete, the results should be made publicly available for stakeholders to review and discuss.

This open and transparent evaluation process will ensure that all parties have a chance to contribute to the decision-making process and that the outcome is based on sound scientific and economic evidence.

Additionally, this process will help to ensure that the restoration efforts are equitable and financially responsible.

6 Risks and mitigation

Description of risk	Risk rating	Mitigation strategies
Public outrage at a poor environmental and financial decision	10/10	A full, open and transparent feasibility be undertaken in conjunction with all stakeholders, using best practice nature-based solutions as indicated by ICER and the attachments 1 & 2.
Access to latest Natural and ecosystem Science advice	9/10	Full access to ICER and the 16 highly recognised Australian and International Scientists on the Panel would be made available for consultation and advice. Also available is the full data set of an investigation conducted on a similar international project to ensure quality modelling. Please see attachment 3.
Resources for works	7/10	Create a unique Private/Commercial/Government project team with competent personnel from all disciplines.

7 Financial impact

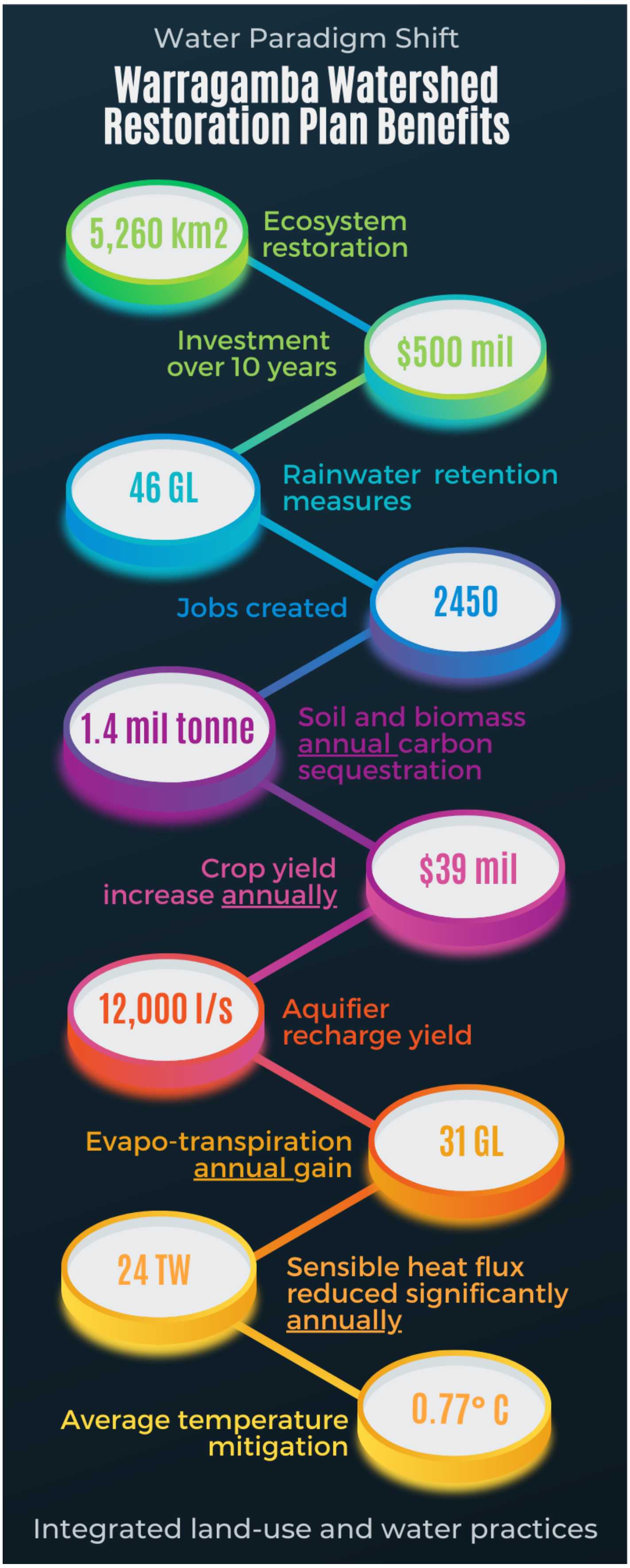
ICER have estimated that a budget of $400,000 should be made available to the feasibility project team to ensure that all resources are able to be utilised. This is a very small percentage of the current estimated build cost. The Commonwealth could share this cost with the NSW Government.

8 Other impacts and benefits

Impact on and opportunities for regional and rural communities

Can stakeholders other than the government address the problem?	No. As it would be a NSW State Infrastructure project, and possibly co-funded by Commonwealth. It is suggested the NSW state agencies should lead and facilitate the project and do so with full community support and recognition for environmental good governance.
What are the co-benefits of the proposal?	• Flood, Fire, Drought abatement. • Australian and International recognition as leaders in broad-scale regeneration projects throughout the world. • Significant Soil Carbon sequestration opportunity helping Australia's emission targets for 2050. • Preservation and protection of sensitive wilderness and cultural areas and the Blue Mountains World Heritage status. • Greater water quality and security for greater Sydney. • Increased soil fertility across the catchment delivering higher quality products for farmers and producers. • Increase in yields for landowners from reduction in inputs. • Excellent credentials for worldwide eco-tourism. • Socially beneficial for regional and rural communities – cleaner air, cleaner water, no damage to indigenous sacred sights. • Significant economic and employment benefits derived from carbon sequestration / carbon credits. See Plan benefits
What are the potential costs?	$500 million investment over 10 years

Restoration Plan benefits



9 Attachments

1. Kravčík Action Plan (Kravcik_Global_Action_Plan.pdf)

2. Kosic Civic Protocol (KOSICE_CIVIC_PROTOCOL_FOR_WATER.pdf)

3. Kravčík Project (Slovakia Recovery Plan (Short) - Michal Kravčík, CSc.pdf)

4. Reference: Strzelecki, Paul Edmund de, (1845). Physical description of New South Wales and Van Diemen's Land: accompanied by a geological map, sections and diagrams, and figures of the organic remains / by P.E. de Strzelecki. Printed for Longman, Brown, Green, and Longmans, London. (Note: prior to 1851 the state of Victoria was part of the colony of New South Wales).

5. Cited from Christine Jones' paper, 'Soil carbon - can it save agriculture's bacon? (http://amazingcarbon.com/PDF/JONES-SoilCarbon&AgricultureREVISED(18May10).pdf)

   Since the time of European settlement, this reduction in soil carbon content represents the LOSS of the ability of soil to store around 504,000 litres of water per hectare. (Christine Jones)

10 Glossary of Terms

DPIE: Department of Primary Industry and Environment

EIS: Environmental Impact Statement

GL: Gigalitre (one billion litres,1,000,000,000)

Ha: Hectare.

ICER: Independent Council for Ecosystem Restoration.

l/s: Litre per second

NFP: Not for Profit

Regolith: Soil Profile

Runnels: usually a sandy, raised ridge on a floodplain that acts as a recharge area to fill surficial aquifers.

SOC: Soil Organic Carbon

A GLOBAL ACTION PLAN FOR THE RESTORATION OF NATURAL WATER CYCLES AND CLIMATE

Michal Kravčík and Jan Lambert
Slovakia and U.S.A.

A global plan of climate restoration of the ***small water cycle***[1] *of regional landscapes, with a goal of decreasing floods, drought, natural disasters, and other undesirable climate changes, and increasing the biodiversity and production potential of all continents, through the introduction of various measures of rainwater retention suitable for all areas of human habitation and usage.*

The Mulloon Institute in New South Wales, Australia is committed to developing the knowledge and practical experience required to advance regenerative land and water management techniques, including but not limited to permaculture techniques for soil hydration and natural sequence farming, and rural landscape management techniques aimed at restoring natural water cycles that allow the land to flourish despite drought conditions. See http://themullooninstitute.org/ and http://www.nsfarming.com/.

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1 see Definition of Terms, Appendix

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1. WHY IS A GLOBAL ACTION PLAN (GAP) NEEDED?

Water management policies worldwide are typically based on the principle of what can be termed the "old water paradigm," which assumes among many other considerations, that surface waters are the main source and reserve of fresh water supplies. Global legislation and investment therefore tend to be oriented toward protecting, developing, and utilizing surface waters with infrastructure such as large reservoirs for water collection and distribution. Although rainwater is the cyclical source of all fresh-water supplies, it is nonetheless often considered to be waste product to be drained away quickly into streams and rivers.

There is a need to perceive by way of a "new water paradigm,"1 that in natural ecosystems, water is integrated into small, regional water cycles, which supply vapor to the atmosphere to condense and form rain, the sun being the driving force of the circulation of water in small water cycles. We also need to appreciate the thermoregulatory processes provided by the movement of water between the surface of the earth and the atmosphere, which maintains the proper temperatures for life on earth[2].

There needs to be increased attention on the gradual, sometimes almost imperceptible impacts of human activities that have led to the reduction of continental freshwater stocks. There is often a misconception that human activities have no direct effect on water cycles, and that temporal and spatial changes are either part of natural, evolutionary processes, or caused by global climate change. Therefore we tend to underestimate the influence of continental freshwater reserves on global energy and thermoregulatory processes, as well as the degrading effects of climate change related to excessive drainage of ecosystems. These human impacts can detrimentally affect extensive territories; these include not only traditionally arid landscapes, but also areas of higher rainfall where human infrastructure drains water away from the land, ultimately to accumulate in the oceans.

The result is a drying up of ecosystems. Two major mechanisms at work are deforestation and agriculture, accompanied by increased stormwater runoff and soil erosion, and reduction of organic matter in the soil, leading to a lessened ability of the land to hold moisture. Another cause is the man-made proliferation of impervious surfaces such as pavement and rooftops that tend to move rainwater rapidly and directly into streams and rivers via storm drains. In this way we treat natural rainfall as a waste product, preventing it from soaking into the landscape and entering the local small water cycle. These local events add up on a continental scale to a significant reduction of groundwater, moisture for soil and vegetation, and water vapor for the air above the continents.

Worldwide, there is no data that demonstrates exactly how much rainwater is lost from small water cycles annually from the continents to the oceans. Research in the nation of Slovakia shows an annual loss of 250 million m^3 through drainage[3]. Based on the assumption that Slovakia has an average rate of dehydration from degraded landscapes, it follows that globally there could be a loss of 760 km^3 of rain-water, which had previously been included in small water cycles. This corresponds to a resulting 2.1 mm rise per year of ocean levels. Here we may find a direct link between the drying of the continents and rising sea levels. Also contributing to the rising levels is fossil water that is pumped from underground and not returned to the hydrological cycle, but instead made to flow to the oceans; this annual increase is 0.8 mm[4]. Since 1993, sea levels have risen annually by 3.3 ± 0.4 mm[5], which corresponds to the estimated total volume of water drained from the continents.

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[2] New Water Paradigm - Water for the Recovery of the Climate, Municipalia, 2007, www.waterparadigm.org, p 72-73

[3] Michal Kravčík, at all: Water for the Third Millenium- „Neubližujme vode, aby ona neubližovala nám", Typopress 2000 in Slovak, 2003 in English

[4] http://www.sciencealert.com/features/20122305-23410-2.html?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%253A+sciencealert-latestfeatures+%2528ScienceAlert-Latest+Features%2529

[5] http://www.sciencemag.org/content/328/5985/1517.full

Not enough attention has been given to studying the effects of ecosystem draining and increasing drought. We therefore present here the context for understanding the impact of ecosystem drainage, leading to the expansion of drought across continents, along with rising sea levels. As mentioned previously, the drainage occurs mainly because of deforestation, agriculture and urbanization of the earth's surface. Annual estimates are 127 000 square kilometers of forests lost and 55 000 square kilometers of impervious surfaces added. We also know that over the course of history an area of 50 million square kilometers of forests have been transformed into agricultural land and urban areas. All of these man made changes to the land have reduced water available for small water cycles. It is estimated that over the last century damaged ecosystems have lost 37 000 km^3 of fresh water from their small water cycles. This volume corresponds to a sea level rise of approximately 10 cm. The deforestation and urbanization of the past 20 years with a resulting annual fresh water loss of 760 km^3 is relatively easy to quantify. There is urgent need for a global program of water conservation for the purpose of restoring this lost water back into small water cycles.

One cubic meter of water, either on the earth's surface or in vegetation, consumes 680 kWh of solar energy[6]. In the last 100 years' loss of 37 000 km^3 freshwater from small water cycles to the oceans, the influence of continental drainage has increased the annual production of **sensible heat**[7] to the atmosphere by more than 25 million TWh. This energy volume is more than 1,600 times the annual production of energy created by all the power plants in the world. This influx of energy into the atmosphere is concentrated principally in areas of clear cut forestland and in the extensive impervious surfaces of large cities. The result is large-scale **heat islands**[8], that affect the circulating currents of air masses in the atmosphere. In turn this is related to temporal and spatial changes in precipitation distribution, with a resulting increase in extremes of weather. Globally such changes include a significant decrease of rainfall in drier areas, with dramatic increases of precipitation in colder regions.

On a global scale, heat islands in drier continents interact with colder air masses, bringing chaotic circulating air currents to ocean and forested areas. Increasing chaotic weather is the result. Such unpredictable weather can include frequent winter warm spells In Europe while at the same time the North American continent experiences extremely cold winters. The cause of these weather changes can be traced to large areas of increased sensible heat production in Africa and southern Europe; the resulting heated air pushes air masses to the north of Europe, over the North Pole, forcing Arctic cold into Canada and the United States. There is also a link between drought and intense downpours, a phenomenon scientists have named "flying rivers"[9].

Heat islands are expanding worldwide, resulting in changes in the distribution of precipitation. A demarcation point may be drawn between damaged lands producing sensible heat and healthy lands simultaneously producing **latent heat**[10] from the earth's surface to the atmosphere. Some areas are experiencing a decrease in precipitation, associated with dehydration of the land from extensive agriculture or urbanization, while other less damaged areas are experiencing intense rainstorms from enhanced vertical accumulation of clouds[11]. Thus heat islands increase the risk of vertical cloud accumulation in the atmosphere above healthy ecosystems. This phenomenon increases the likelihood of even more dramatic increases in severity of the weather including windstorms, tornadoes, and even hurricanes[12].

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6 New Water Paradigm – Water for Recovery of the Climate, Municipalia, 2007, www.waterparadigm.org
7 see Definition of Terms, Appendix
8 see Definition of Terms, Appendix
9 http://www.theguardian.com/environment/2014/sep/15/drought-bites-as-amazons-flying-rivers-dry-up
10 see Definition of Terms, Appendix
11 http://thevane.gawker.com/maps-which-parts-of-the-u-s-see-flash-floods-most-oft-1622076723
12 http://realtruth.org/articles/120414-001.html

The United States is a prime example of weather extremes resulting from ecosystem damage. An inland heat island effect leads to increasingly prolonged droughts, interspersed with frequent tornadoes and intense downpours in extensive agricultural areas of the United States (from the state of Kansas radiating outward)[13]. The same effect, while preventing cloud formation in the interior, also leads to excessive vertical cloud accumulation on the humid East Coast[14]. Thus the severity of so called superstorms, accompanied by widespread flooding, on the eastern seaboard can be traced to the production of sensible heat in dried out areas of the country's interior. In California, on the West Coast, prolonged droughts are associated with deliberate draining of the land that can be traced back to the nineteenth century.

The next issue to consider is the impact that drainage of continents has on the earth's crust. There is a high probability that the weight of the drained water, about 37 000 km^3, having been removed from the continents and added to the oceans, will affect pressure conditions inside the geological structures of the earth. Altering the tension in the earth's crust presents a realistic prospect of more frequent earthquakes in the future. According to the IPCC Panel, water levels in the oceans have increased by about 15 cm in the last hundred years[15]. There are no active simulation models available that link pressure changes in the earth's crust with earthquakes. However, research on the impacts of tropical cyclones, and subsequent activation of earthquakes in Taiwan and Haiti, link the impact of large amounts of eroded soil during floods with subsequent activation of an earthquake[16]. Changes in the earth's crust brought about by drying of the ecosystems by heat islands, however, is a little studied although identifiable human impact.

Increasing production of sensible heat causes a decrease of rainfall in dry areas and an increase in wetter and colder areas; it also increases thermal differences between the drier, hotter areas and cooler, humid areas. This is demonstrated by the principle of the biotic pump[17], which shows that the degradation of ecosystems is causing a decrease of inland precipitation. Even small changes in rainfall amounts and distribution can lead to ecosystem damage. Research in Georgia in the Caucasus confirms this through records of historical rainfall changes linked with ecosystem degradation[18]. Another example is the island of Hawaii in the Pacific, where an area of 10 000 square kilometers encompasses ten precipitation bands. While the western part of the island receives only 250 mm rainfall per year, the northeastern portion is drenched with more than 6 000 mm annually. Modern science describes this phenomenon as the impact of the **mountain massif**[19], which causes condensation of clouds before they reach the western side of the island. In this case, the interior of the island comprises mountain ranges containing stretches of active volcanoes, with crests exceeding three thousand meters above sea level.

It is not yet widely known that **sensible heat**[20] production, from heated dry land areas, produces a very significant effect by both increasing precipitation in wet areas and decreasing precipitation in dry areas. As mentioned above, historical temporal and spatial changes have occurred in Caucasus, Georgia, over a 10 000 year period; these changes confirm the impact of land use as evidenced by a rise in precipitation and temperature differences among the region's climatic zones. Additional confirmation comes from changes that have occurred in the hydrological cycle of the island of Cyprus. Here rainfall has decreased by more than 15 per cent, despite the fact that water is captured by more than 100 dams in an area of almost 10 000 square kilometers. Water problems on Cyprus continue to increase every

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13 http://www.ldeo.columbia.edu/res/div/ocp/pub/cook/Cook_Seager_Cane_Stahle.pdf
14 http://nca2014.globalchange.gov/highlights/overview/overview
15 https://www.ipcc.ch/ipccreports/far/wg_I/ipcc_far_wg_I_chapter_09.pdf
16 http://www.miami.edu/index.php/news/releases/study_links_tropical_cyclones_to_earthquakes/
17 http://www.hydrol-earth-syst-sci.net/11/1013/2007/hess-11-1013-2007.html
18 https://minerva-access.unimelb.edu.au/handle/11343/39418
19 see Definition of Terms, Appendix
20 see Definition of Terms, Appendix

year; if a comprehensive program of ecosystem rainwater conservation is not implemented within the next decade, Cyprus could face a crisis situation of water scarcity.

From the aforementioned statements, it can be seen that drainage from degraded lands, causing subsequent drying of their ecosystems, can have a profound effect, contributing to climate extremes. Such phenomena occurring in drained, dried areas are often explained as an impact from a greenhouse gas effect from increased levels of CO2 in the atmosphere. A growing number of recent scientific papers, however, have increased our knowledge of the climatic impact of damaged and degraded small water cycles associated with decreased and damaged vegetation. Water cycles and vegetation have functioned together in coexistence over geological eons, this relationship being disrupted historically and currently by humans practicing poor land management[21]. Giving attention only to the greenhouse gas model of climate change, while ignoring land mismanagement, may result in a large part of harmful human activity not being addressed, therefore preventing global implementation of effective measures.

Conclusion and Action Needed

For climate change due to anthropogenic drainage and vegetation depletion, the major necessary intervention is to restore water in dry, damaged ecosystems, a measure which can be achieved with rainwater retention and soil erosion control. Consistent and widespread restoration of native vegetation and soil fertility will bring about restoration of the natural water cycle. It will also achieve increases in food production, fresh water supplies, and biodiversity, while mitigating the occurrence of severe weather, and decreasing the volumes of storm water flowing down rivers, thus ultimately decreasing sea levels. This can be accomplished; it is only necessary to mobilize stakeholders, from local and regional to national, international, and global levels.

Despite the above-described realities of the deterioration of water cycles, and that water as a resource is extremely critical to many public investments, current efforts are insufficiently responsive to the nature and dynamics of the ecological processes taking place. Hydrological cycles have been negatively affected in many types of forested, agricultural, and urban landscapes, as well as in the transportation and industrial infrastructure and other developed areas. These intensive human-caused effects accelerated in the twentieth century, especially in recent decades.

Unfortunately, a large proportion of urban infrastructure (such as impervious surfaces and storm sewer systems) is encouraging the continued drying of the landscape ecology, which not only compromises the balance of water, but also causes an increase in urban heat islands; subsequent changes in rainfall distribution indicate an altered local and regional climate. The loss of water into rivers also contributes to rising sea levels. By not taking these effects into consideration, high level decision makers and global stakeholders are operating under the inaccurate concept that all climate change can be mitigated solely through the reduction of greenhouse gases.

Forecasts suggest that stable hydrological regimes in landscape ecosystems are the key determining factor of economic, social, and cultural welfare of all human communities, from local to global scale. Such landscapes are far more equipped to absorb rainwater and withstand extreme weather such as intense rains and drought. Such a desirable state can be achieved only by ecosystem improvements that strengthen biodiversity and soil production potential through improved hydrological regimes.

Current knowledge of hydrology in ecosystems worldwide, indicates that without a fundamental change in land and rainwater management, especially in urban areas, the risk of extreme floods and droughts will rise in coming years. Problems of overheating and drying will increase exponentially if we do not

[21] Huryna, Hanna: Effect of different types of ecosystems on their meteorological conditions and energy balance components, University of South Bohemia, České Budejovice, 2014

stop the perennial surface drainage of landscapes. The solution is to restore degraded landscapes by means of natural regeneration of soil moisture to benefit small water cycles. This will create favorable conditions for prevention of floods, droughts, and other natural disasters.

Massive rainwater retention is necessary to achieve a state of sustainable life on our planet; it is time to mobilize politicians together with citizens. The challenge is to make urgently needed decisions to achieve an integrated, holistic system of rainwater management. By doing so, in addition to preventing floods and droughts, we will also strengthen biodiversity, increase soil fertility and productivity, and restore a more healthful climate.

In varying degrees, activities of human civilization adversely affect water in the landscape. It is imperative that we identify those activities and supply necessary interventions that systematically provide comprehensive rainwater storage to landscape ecosystems. It is also necessary to identify actions that will restore damaged landscapes and thus reduce current negative human impacts.

Although floods and droughts are to some degree natural phenomena, major human interference in natural processes includes changes in stormwater runoff from urbanization, faulty agricultural practices, and deforestation; these have significantly altered the state of water in ecosystems worldwide. The result is increased risk of floods, loss of soil productivity and biodiversity, as well as contributing significantly to climate change. Thus, nature has become quite vulnerable.

What is needed are not new, larger water projects based on the principle of the old water paradigm, but instead ecosystem water protection achieved through water restoration in soil and landscapes, the basic principle being simple in concept: As much as possible harvest rainwater where it falls.

Inappropriate human interference with natural processes must be stopped; governments have the responsibility to support water management policy which is consistent with environmental protection and landscape conservation.

Transferring water management problems from one region to another will do nothing to alleviate climate problems caused by poor land management. The only suitable strategy for such climate recovery is a three-step approach: 1) capture, and 2) retain rainwater in the landscape, and 3) transfer only the excess that cannot be retained into watercourses. Integrated water resources management covering an entire river basin must have priority over flood risk management restricted to isolated stream sections.

This approach makes it possible to recover the health and climate of an entire watershed in an efficient, inexpensive and sustainable manner.

Jan Lambert photo

NATURAL WETLAND: USA- State of Vermont- Natural wetlands provide valuable rainwater retention as well as important wildlife habitat.

2. GAP BACKGROUND

The requirements for an effective approach to comprehensive, integrated flood protection are not being provided by the predominant concepts and methodologies. Protection is needed for watershed ecosystems on a global scale, in order to mitigate not only floods, but drought and other natural disasters, particularly associated with climate change, now and into the future.

A welcome start has been made through some efforts at global and continental legal standards and strategic decisions concerning floods, drought, and climate change; namely, the EU Water Framework Directive[22] and the Millennium Development Goals[23], among other global climate protection programs. Implementation of these programs is slow, however, as there is not enough provision for strengthening the ability of communities to solve their local water problems.

The urgency of the need to address protection against floods, drought and climate change was confirmed by the Council of Europe for the Environment, which in December 2012 adopted a new water policy based on a directive for water retention[24]. The EU included as background information, the Slovak government's Program of Landscape Revitalization and Integrated River Basin Management, adopted in October 2010[25] and launched in the spring of 2011 to reduce flood risk, drought and other risks of sudden natural disasters.

The Slovak program is based on a concept of social responsibility for protecting its watershed ecosystems against floods, drought and climate change. It is also based in part on the Millennium Development Goals and other documents cited by directors in the field of EU water policy.

2.1. Global millennium goals

Humanity and environment have formed a circular relationship: environment impacts human life and likewise all human activity impacts the environment. Deterioration of the earth's environment is directly related to global challenges increasingly presented by human populations. Water-related environmental threats are manifested in many forms including global warming, air pollution, loss of forests and biodiversity, desertification and soil degradation, diminished drinking water supplies, and river and ocean pollution. To address all these problems, as well as other environmental threats such as air pollution and genetically modified crops, what is necessary is a sustainable development strategy on a global scale.

To reach a sustainable strategy, the current Millennium Development Goals for climate recovery need to comprise not only climate change mitigation, but also expanded strategies to bring about healing processes in the climate. These are needed further to assure abundance of clean water for human use and for biodiversity, reduction of desertification and expansion of forests, increased soil fertility, and reducing ocean pollution and sea levels for the wellbeing of island and coastal areas.

2.2. New water management policies of the United Nations

New, expanded water management policies will enable the United Nations to carry out its strategic decision to focus on green growth, efficient use of natural resources, and resilience to natural disasters; economic security will be increased not only in the water sector, but also related sectors that encourage and foster innovation for sustainable communities and economic prosperity of nations. By means of restoration of ecosystems and water retention strategies, UN member countries can ensure their water

[22] http://ec.europa.eu/environment/water/water-framework/index_en.html
[23] http://www.unmillenniumproject.org/goals/
[24] http://ec.europa.eu/environment/water/blueprint/index_en.htm
[25] http://archiv.vlada.gov.sk/krajina/data/files/7183.pdf

security by using the best available techniques and measures. They can reduce the vulnerability of their own countries to floods, droughts, and natural disasters, while simultaneously improving soil fertility, biodiversity, groundwater supplies, and the moderating effect of small water cycles on regional climates. Joining with other nations in a united effort will help bring about environmental healing on a global scale.

Effective land management and planning for all countries requires strategies devised to permeate landscapes with adequate levels of rainfall and snowmelt, which will bring about the return of stable regional, small water cycles to aid in local, and ultimately global, climate recovery. Restoration of vegetation and water in urban and rural landscapes will improve each country's ability to retain water and thus improve the functions of ecosystems. The highest priority is the retaining of rainwater where it falls, especially in areas altered by human activities. Improving the infiltration of rainwater into the soil to an optimal saturation level will increase ground and surface water resources, and thus vegetation, soil fertility, social benefits and economic prosperity. Of utmost importance is the prospect of establishing permanent vegetation cover and replenished water sources, which will help ensure livable climates for all countries.

2.3. Programs of landscape restoration and integrated river basin management

All of the world's continents are suffering from floods, droughts, forest and grassland fires, diminished groundwater, and undesirable climate changes. In economic terms, the damage has exceeded billions in US dollars annually, and continues to rise. At the same time economic crises have substantially increased unemployment. And yet, an opportunity arises now to solve the above-mentioned problems, by learning from the successes of the 1930s New Deal Program in the United States[26].

Instituted by President Franklin Roosevelt during the Great Depression, the American New Deal embraced a large number and variety of initiatives at federal, state, and local levels. Jobs were created in line with Roosevelt's decree that unemployment was a "drug unnoticeably destroying the human spirit." With the benefit of hindsight, we can say that the millions of jobs created also resulted in much healthier landscapes with ponds, water catchments and terraces to slow erosion and soak up rainwater, along with replanted forests. Americans enjoy these benefits to this day.

In January of 2009 at the Davos World Economic Forum, UN Secretary-General Pan Ki-Moon called on the world's leaders to transform the global economic crisis into a "Green New Deal" with new jobs to fight climate change[27]. Ban Ki-Moon called for "a new constellation of international cooperation — governments, civil society and the private sector, working together for a collective good," as well as "breaking the tyranny of short-term thinking in favor of long-term solutions."

At present about 760 km^3 of rainwater are lost from landscapes of the continents annually, through storm runoff failing to be absorbed into the soil. This represents water that should be replenishing soil moisture and groundwater reserves, and stabilizing regional temperatures and rain cycles through the **transpiration** of plants[28]. The necessary goal is to return this lost water back to the continents through deliberate human actions. A variety of possible measures would include terraces, ditches, and swales along the contour lines of slopes; check-dams; and depressions, water-holdings, fire ponds and polders. Many effective measures in rural areas do not require highly skilled labor and could thereby provide jobs for the local unemployed. A global goal of rainwater retention needs to be set, of approximately 1 000 km^3 over the span of 10 years. We estimate that one worker can create water-holdings for 1 000 cubic meters per year. This will translate to 50 million jobs over the next decade.

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[26] http://www.history.com/topics/civilian-conservation-corps
[27] http://www.un.org/apps/news/story.asp?NewsID=29712#.VQdEBU10xjo
[28] see Definition of Terms, Appendix

In 1993 the government of Slovakia had planned to create water supplies by building a dam with a capacity of 700 liters per second, costing 350 million US dollars, that would have threatened the very existence of five historical communities that were over 700 years old. However, the People and Water NGO has developed an alternative to the proposed dam[29]. Their "Blue Alternative" plan is to restore water resources throughout the dehydrated ecosystems covering an area of 5 500 square kilometers, by employing measures that respect the rights of the inhabitants of historic villages and also promote a sustainable lifestyle. The Blue Alternative would provide 4 000 liters per second capacity, adequate for all interests (city water supplies, agriculture, industry, biodiversity) with water retention in the landscape of at least 80 million cubic meters. There would be a similar cost of about 350 million US dollars, but with an estimated minimum of five times the amount of water storage gained.

A small pilot project of the Blue Alternative plan was implemented by volunteers of People and Water in 1996, in a micro-watershed of the small dried up valley of the Torysa River, where water flowed only during heavy rains. Volunteers built slope depressions, water-retention swales, and beam weirs to slow down rapid storm runoff from the steep slopes, successfully retaining rainwater underground. New springs emerged and the formerly dried up valley now enjoys a steady, constant stream flow.

Based on the Blue Alternative's solutions, the Slovak Republic government adopted the *Landscape Revitalization and Integrated River Basin Management Program for the Slovak Republic* (October 2010)[30]. The principal tool for addressing ecosystem problems, as well as flood and drought risks, was rainwater retention improvements in damaged sections of the landscape. A goal was set to restore landscape water retention capacity of at least 250 million cubic meters for the whole of Slovakia.

Within the brief period of 18 months, 488 communities involved in the *Program* achieved 100 000 separate water retention measures in degraded landscapes. A retention capacity of 10 million cubic meters was restored or newly constructed, amounting to four per cent of the total amount proposed during the expected ten-year implementation period. Between October 2010 and March 2012, the *Program* provided 7,700 seasonal jobs, mostly for chronically unemployed workers, who at least were able to benefit from the dignity of socially beneficial, temporary employment[31].

The implemented measures aided in lessening the flooding risks of the torrential rains of 2011; the retained storm water was subsequently released gradually, during the next six months of extreme drought in Slovakia that same year. By setting a priority on water retention measures in the upstream sections of the watersheds, flooding and drought risks were moderated in 500 to 1 000 municipalities located lower in the river basins. Numerous representatives of towns and villages expressed satisfaction with the *Program* after many years of helplessness and worries in regard to the threat of severe storms, flooding, and soil erosion.

[29] http://www.goldmanprize.org/1999/europe
[30] http://archiv.vlada.gov.sk/krajina/data/files/7183.pdf
[31] http://www.ludiaavoda.sk/data/files/44_kravcik-after-us-the-desert-and-the-deluge.pdf

3. GAP OBJECTIVES AND HOW TO ACHIEVE THEM

3.1. Prevention of floods, drought and climate change

The aim of the program is to develop and activate long-term conditions that lead to socially practicable and economically effective functioning of a complex and integrated system of environmental protection, to ensure the prevention of floods, drought and climate change across various ecosystems, water basins, nation states and continents.

The prevention of floods, drought and climate change can be tackled in a three step approach based on the following sequence:

(i) first, capturing rainwater in the eco-system where it falls **– retaining**

(ii) second, accumulation of rainwater in the eco-system **– storing**

(iii) last, releasing the excess rainwater, which the ecosystem is not capable of absorbing **– draining**

The above mentioned approach is in line with the main focus and priorities of the program: **rainwater retention in ecosystems, slowing the runoff of rainwater to enable infiltration, and the revitalization of damaged ecosystems, water basins and territories.**

Preventive measures should be designed in ways that will increase the effectiveness of existing water works establishments to protect against floods and lack of water supply, and increase protection of inhabitants and their health, private and public property, cultural heritage and other material and nonmaterial things.

One of the basic steps for the prevention of floods, drought and climate change will be the restoration of an ecosystem's water basin to its natural self-sustaining state where it will be able to retain rainwater, permit its infiltration into the soil and thus increase the quality of the soil. The restoration of the functions of an ecosystem will revitalize the use of the land for its inhabitants; it will strengthen ecological quality and productive potential in such a way, that water basins will no longer be sources of drought and flooding; at the same time biodiversity will be increased and the climate revitalized.

3.2. Rainwater Retention

The aim of the program is to retain rainwater in a region in order to restore the small water cycle. Rainwater runoff is artificially accelerated within current deteriorated ecosystems. Rainwater on land fulfils various purposes; it significantly contributes to the renewal of an ecosystem's ability to produce water and food, and support biodiversity and a healthy climate. The retention of rainwater in land leads to increased water retention capacity of the landscape, replenishment of underground water aquifers, and thus to increased harvests and biodiversity. Additionally, it mitigates the risk of flooding and drought while alleviating climate change.

The key objective is to create a global program aimed at the development of water retention systems and technical solutions capable of retaining up to 760 m^3 of rainwater across forested, agricultural and urban landscapes worldwide. In turn the proposed water retention measures will require their fair share of maintenance and service in order to retain their functionality. It involves a cyclical process of water retention corresponding to the estimated annual loss of freshwater from the continents resulting from damaged landscapes.[32]

An important factor for increasing the effectiveness of the program, as well as the impacts of the created multiplier effects is the implementation period of the program, necessary for the development of

[32] Ing. Michal Kravčík, CSc. a kolektív: Voda pre tretie tisícročie – „Neubližujme vode, aby ona neubližovala nám", Typopress 2000.

cyclical water retention capacity. The program time line is expected to be based on both short-term (2020 start) and mid-term (2030 start) horizons dependent upon the global negotiations processes and the ability to commence projects. This program can be initiated across multiple levels; from the global, to continental, national, regional, and all the way down to the local or even individual level. As high level negotiations can be complex, it is much simpler and more effective to start the program from the bottom up at the individual level and expand it to higher levels until it encompasses the entire globe. It has the potential to turn into a global people's movement for the retention of rainwater across all regions, nations and continents.

It is necessary to retain about 100m^3 of rainwater for every inhabitant on the planet. This means that, if every person on earth implemented measures to retain 100m^3 of rainwater in their area within one year, enough water retention measures would be achieved to retain more than 760 km^3 of water, which would in turn replenish the small water cycles in the atmosphere above land. This aforementioned rainwater, returned to the small water cycles, would lead to a decrease in ocean levels by 3 mm. Even if some doubts exist about the global program's ability to reduce ocean levels, renew the climate or revive the small water cycles, it is nevertheless legitimate to initiate such a program, based on increased water resources such as that evidenced from an experimental program in the nation of Slovakia. Based on the findings of the Slovakian model, it can be expected that, at the global level, the retention of rainwater on land will result in the increased yield of water resources by more than 30 000 m^3 per second and therefore will kickstart the process of decreasing the production of sensible heat into the atmosphere, with an expected yearly reduction by 500 000 TWh. This will effectively lower the risks of natural disasters as well as occurrences of extreme weather events.

3.3. Revitalization and Restoration of a Damaged Landscape

The restoration of damaged ecosystems is one of the main goals of the GAP, which actively motivates communities, regions and nations to revitalize their local micro-climates. The key condition for the prevention of flooding, drought, climate change, restoration of ecosystems and soil fertility as well as the decline of ocean levels is the retention of rainwater in ecosystems across all continents on earth. In this way, specific local needs are defined by a global solution to the problem. The economic, social, environmental and cultural value of local communities will drastically improve with the systematic retention of rainwater. This trend will lead to the gradual increase in economic competitiveness of a region, even a currently devastated one, which will contribute to global security. Additionally, it will lead to prosperity, social justice, environmental conservation and cultural development, as well as promote biodiversity and global food and water security.

The deployment of a global program for the renewal of the production capacity of ecosystems will provide measures that will slow down the surface runoff of rainwater and allow it to infiltrate into the ground, thus reducing erosion and the risk of flooding. Retention of rainwater on the land's surface and the slowdown of runoff into rivers and seas will increase water reserves across the globe. This will enable rainwater's key functions to develop, which are deemed essential for long-term sustainable development as outlined in the Millennium Goals.

A global program for the retention of rainwater enables the establishment and development of various techniques for the retention of rainwater in forested, agricultural, and urban areas. The program will also align the goals of the retention of rainwater on land with the needs for the revitalization of watercourses and the cyclical flood time adjustment, effectively to protect any given area from disasters and floods.

The focus is on the establishment and subsequent use, spread and development of various techniques for the ecological revitalization of ecosystems, including techniques for rainwater infiltration into the ground. Small scale technical measures on land may be applied in order to serve the various above mentioned purposes, such as flood and drought prevention and climate change mitigation.

3.4. Changes to the mindset

The GAP is primarily aimed at changing the mindset of humankind to consider all water as part of ecosystems, in order to understand water's interactions and complex interconnections. The program will be the source to understanding the multiple global functionalities of rainwater and to the realization of its effective and strategic potential for a wide array of uses.

The contribution of the program in regards to its philosophical basis, is humankind's understanding of the necessity to reduce rainwater runoff from land, where at present, instead of its great utility potential to contribute to the revitalization of ecosystems, it is instead being excessively drained off the land, which leads to flooding during times of intense precipitation.

Part of the program's philosophy calls for a change to land use management, currently heavily focused solely on production, to a more ecologically stable approach with an emphasis on the rehabilitation of damaged ecosystems. This is a necessary action for long-term sustainability of ecosystems and their ability to protect water and biodiversity, reducing the risk of flooding and drought as well as decreasing the damages resulting from natural disasters and extreme weather events.

The GAP supports a transition in the conventional use of ecosystems to a more integrated and holistic approach. The program promotes the revival and development of renewable natural resources (water, soil, vegetation, forests, bio-diversity, etc) and fulfils the demanding conditions set out in the sustainable development goals formulated in Agenda 21 of the Global Millennium Goals.

Michal Kravčík photo

SLOVAKIA: Pavol Šuty is a forest and water specialist, and head of the Skalite Village Flood Prevention Project. The focus of the project is the building of check dam cascades on small streams, to save soil and water for natural stabilization of hydrology and biodiversity. He has experience with building more than 4 000 check dams and other water holdings. In Slovakia more than 100 000 separate water holdings were constructed from 2011 to 2014.

4. PRINCIPLES AND MEASURES OF THE GAP

It is absolutely necessary to implement the recovery plan for the small water cycles on a global scale; therefore we recommend the coordinated development of national action plans in order to strengthen macro-economic effectiveness of the plan.

4.1. Process management at the national level

The Global Action Plan (GAP) for the renewal of small water cycles and climate is based on the principles of activation and management across all continents, focused on the renewal of small water cycles. The goal is the creation of dynamic, interactive and long-term conditions for retaining rainwater on land across the world. The intent is to restore and maintain healthy ecosystems that involve the participation of various stakeholders, including the public sector as well as various private sectors. This action will include effective use and sharing of institutional capacities as well as creative potential and technological resources, creating an integrated multi-sectoral participation model application of the GAP.

4.2. Macroeconomic effectiveness

The financial resources designated for the realization of the Global Action Plan, are from a long-term perspective, the most important criteria for most countries, to ensure environmental, economic, social and climate security for a sustainable way of life. Each country will need to address a multitude of global issues while simultaneously providing enough water for its people, food, the environment, sustainable development and climate. The following social dimensions are an effective measuring tool for macroeconomic performance influenced by the GAP:

- ✓ The effective use of financial resources for the implementation of GAP via legislative measures, which will motivate all landowners and managers to retain rainwater across all ecosystems (forested, agricultural, urban).
- ✓ Systematic support of the utilization of rainwater for multiple uses across all sectors of the economy with incentives for innovation, research and development, services and job creation. These measures will encourage substantial participation of all stakeholders in the use, protection and restoration of water resources on which people, nature and climate depend.

Jan Lambert photo

NATURAL FOREST: USA- State of New Hampshire-Forested areas provide excellent shading, infiltration, and transpiration to regulate small water cycles in the landscape.

5. NATIONAL ACTION PLAN (NAP) TIME FRAME

The Global Action Plan shall be implemented within the next ten years from 2016 to 2025 in three inter-connected stages: global activation of the action plan, activation of the national action plans (NAPs) and their complex implementation within each nation's borders.

5.1. Global activation of the action plan

During the first phase of the action plan, all systematic processes will be set in place, which are essential for a multitude of institutions across the globe to develop systematic measures, in order to reach the common global goal of returning a minimum of 1 000 km^3 of rainwater back to the small water cycles above land annually. Due to ill-advised human activity, rainwater has been gradually drained from the land into the ocean, resulting in a sea level rise of 3mm. Based on these grounds, the United Nations shall accept the role of giving responsibility to all nations for the renewal of small water cycles and recovery of the climate, beginning in 2016, corresponding to the UN's date for mobilizing citizens around the world.

5.2. Activation of National Action Plans

The implementation of each National Action Plan (NAP) will begin the process of returning lost water to the small water cycles and micro-climate of each country. The NAP will bind the governments of individual nations to develop and approve legislative measures and implement the NAP via all stakeholder groups (managers and landowners of forested, agricultural and urban ecosystems).

✓ Legislative Changes
Governments are to support the legislative changes required for the activation of the NAP including the development of interactive mechanisms for its effective application, beginning in 2016.

✓ Kickstarting projects
Within the first year, all governments employing a National Action Plan will be responsible for ensuring the implementation of kickstarting projects in the most damaged regions of their countries, which will in turn become real life test labs for further developing technological processes for capturing and retaining rainwater.

Pilot projects, as an activation phase of the NAP, shall be implemented under binding legislation as well as under the current institutionalized management for integrated protection of water. This provision will provide a useful source and effective feedback for beginning to enact legislative changes and institutional reforms for the effective management, use, protection and renewal of water resources, creating global water security for future generations.

5.3. Regional Program Implementation

This phase of the NAP, within the regions of a country, builds upon the preceding phase and will be deployed after the legislative conditions are in full effect for the large scale implementation of the action plans, for which the conditions are: 1) initial approval of legislation to enable the launch of the NAP, 2) the effective and efficient management of river basins within and between regions, and 3) the established rules and regulations for financing, organizing and managing the NAP.

✓ Multi-Sector Application of the Program
Full functionality of the fundamental principles of the program will not only enable its nationwide implementation of the program, but will also lead to the development of multi-sectoral activities; these will lead to innovation in products and services and will serve as a prerequisite for effective macroeconomic growth and long-term increase in employment.

The scope and complexity of the program and its economic multiplier effects will be further described in chapter 7.

Michal Kravčík photo

SOUTH KOREA: Green Roof Gardens-Moo Young Han, professor at Seoul National University, directs the Rainwater Research Center at the University. He is doing voluntary service of rainwater retention demonstration projects in Korea and developing countries.

Michal Kravčík photo

PORTUGAL-TAMERA - Bernd Mueller is a permaculture and water specialist, and head of Tamera's ecology project. The focus of the ecological work of Tamera is on building the Water Retention Landscape as a far-reaching approach to healing the land, and regenerating water supplies, topsoil, pasture and forest, and greater diversity of species. See www.tamera.org.

6. ACTIVATION OF THE GAP – THE RENEWAL OF SMALL WATER CYCLES

The establishment of a new generation of water-related legislation across all countries of the world will be the result of technical and legal analysis, and documentation primarily focused on the following areas:

6.1. The increased retention of rainwater in degraded ecosystems

Defining activities via the legislative process for increasing the water retention capacity of ecosystems, water basin and entire countries, while simultaneously reducing the risk of flooding, drought, erosion, pollution and other water-related problems, will be identified and specified with established legal rules, tools and mechanisms for the recovery or water in the small water cycle and climate, which will enable:

(1) the reduction of the negative effects of human activities that increase the risk of flooding, drought and climate change.

(2) the activation of the positive effects of human activities that reduce flooding, drought and climate change.

(3) the removal of existing burdens created by past human activity that have increased the risk of flooding, drought and climate change.

(4) consistently applying the mechanisms for negative and positive motivation for the rehabilitation of damaged and dry land, and resolving the consequences of neglecting responsibility or neglecting one's duties based on effective legal norms and standards outlined by the interactive process of legislative changes;

Effective in all water basins, territories of all member countries of the United Nations: • forested land • agricultural land • areas with major waterworks projects • developed transport and industrial infrastructure • urban settings (towns and cities).

6.2. Effective and efficient management of river basins

The legislative process will create conditions for the effective and permanent renewal of water in small water cycles via the integrated protection of water basins and rivers across the world within which all technical and legal aspects will be evaluated, with a particular focus on the following:

(1) Decentralization of water management in river basins, moving toward local stakeholder management where key roles will be carried out by local communities and municipalities:

- ✓ The necessary legislative changes for institutional reform to water management in river basins will support the mobilization of all interested parties for the permanent renewal of water in small water cycles. This should be prepared in all countries on the basis of relevant professional and legal analysis, by developing documentation that will aid in setting up the necessary legal conditions for such transformation; in turn this will strengthen community responsibility for water resource protection and the renewal of water in small water cycles.

(2) Cross-sectoral integrated management of water resources in river basins by increasing the liability of owners and managers of ecosystems with a focus on rainwater retention:

- ✓ Within the agreed-upon legal norms and standards, each country will define the rules and develop a common procedure for the implementation of its national plan for the renewal of the small water cycles and climate, through the accountability of all stake holders for retaining rainwater on damaged landscapes. Integration will be based on the reform of existing institutions through the legislative process, which prescribe the rules and conditions to which all stakeholders must adhere, in order to help pro-tect, use and permanently renew water from small water cycles.

(3) Decentralization of management of newly-created water sources in dried out regions, that have been created as a result of action plans, transferring to owners and managers of newly revitalized land-scapes:

- ✓ Countries with extensive dried out and damaged water basins will develop technical and legal norms and standards that will enable the management of the new water sources resulting from efforts of those implementing action plans to restore water in small water cycles. The programs will prescribe new rules for the economic utilization of new water sources and their sustainability, subject to the conditions laid out in the public interest and in macro economic efficiency.

6.3. Financing, organization and management of the program

The legislative process at the national level will ensure the conditions for long-term financing, orga-nization and management of the program within the complex implementation phase, and will result in:

(1) Operating strategies in which professional economic, financial and legal analyses will be processed, reviewed, evaluated and determined:

- ✓ Financing of the GAP will be supported through the method of provisioning and the legal form of the administering financial resources, by which the scope of financing resources of the program will be formed by international sources stemming from global communities (UN, World Bank),international development funds, state budgets and other financial resources from around the globe.
- ✓ Structured instruments and the conditions for the efficient allocation of financial resources for program implementation will be necessary.

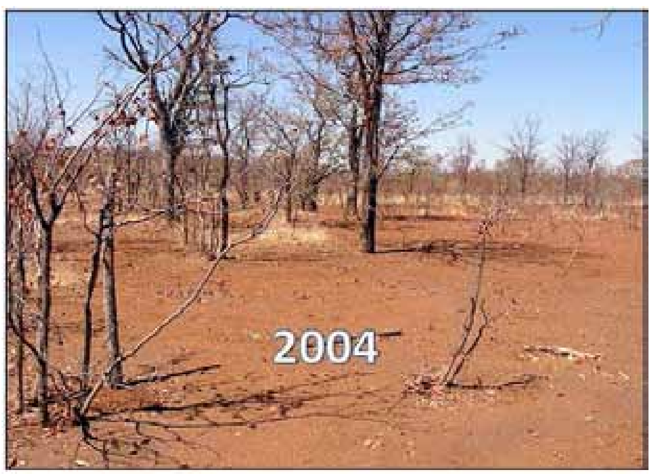
(2) System of organization and management of the program defining the procedures, rules and criteria for submission, approval and monitoring of the program implementation project will be the responsibility of individual nations:

- ✓ At the UN level, quotas will be developed for all member nations, outlining the total capacity of rainwater retention on the principle of sustainable and permanent water renewal in small water cycles, and will further define the priority areas that should have access to international aid due to their extensive drought.
- ✓ The organization of administering and managing the approval and monitoring process of the GAP implementation projects will be the full responsibility of individual countries. Priority areas in countries affected by extensive drought eligible for international assistance will be available in the form of grants whose main purpose will be to kickstart the permanent renewal of water in small water cycles.
- ✓ For determinig the assessment and monitoring the effective use of public resources in the GAP implementation projects, support will be sought from international scientific, technical and educational, as well as independent, institutions that are not subject togovernment structures.
- ✓ The legal form of effective professional management of the program will consist of (i) managerial management (an executive body) and (ii) effective monitoring andcontrols (supervisors).

The World Bank will fund the development of GAP projects for each river basin that extends beyond at least three countries, aimed at kickstarting projects for the renewal of water in small water cycles, where effective management capacity will be developed as well as technological solutions for the renewal of water in ecosystems and the effective use of public resources. The monitoring of these start-up projects will be carried out by independent civil society groups.

Jan Pokorný photo

AFRICA: Kenya, Naivasha Region--Jospat Macharia of Nabibi Farm utilizes rainwater retention to achieve food production for 80 persons even in long dry periods; water storage for irrigation of crops is provided by tanks that hold 100 cubic meters, distributed according to the needs of each plant species. Abundant vegetation has also provided wildlife habitat.



Photos courtesy of Africa Center For Holistic Management (top) and Seth Itzkan (bottom)

AFRICA: Zimbabwe- Holistic Grazing Management restores carbon and water to degraded landscape by changing the way in which livestock is grazed. *See Chapter 7.2.2.*

7. IMPLEMENTATION OF THE GAP AS NATIONAL ACTION PLANS

To achieve combined multi-sector and economic incentives of the Global Action Plan (GAP) at the national level, we recommend an integrative approach on two levels:

(1) Implementation of the National Action Plans (NAPs) through integrated projects for permanent restoration of water in small, regional water cycles, via GAP-based watershed, or basin projects.

(2) The implementation of NAPs into economic processes of public and private business sectors via multiple economic incentives.

7.1. Integrated Reconstruction Projects to Restore Small Water Cycles

Through partnerships for basins, work will include preparation, processing and realization of integrated reconstruction projects for restoration of small water cycles in the basins, achieving funding, assuring long-term operation and maintenance of all technical measures, and managing the water and landscape works achieved, as well as buildings and other necessary additions or changes to existing infrastructure[33]. These are to be created through a declaration of the common goals of the partners in accordance with the GAP, to take responsibility for the ecological integrity of the basin.

Motivation of a basin's partnership stakeholders lies in their responsibility for permanent restoration of small water cycles, together with determining the incentives of all stakeholders for the preparation, processing and realization of an integrated Partnership Action Plan (PAP) for the river basin. Multi-sector participation in startup projects, activated with support of the World Bank, especially at the beginning stages of each PAP, will be possible only through active participation not only of governmental agencies, but also scientific and civic sectors. This may require significant changes to existing institutions that manage basins, which will lead to restructuring and more effective actions. NAP programs will thus become multi-faceted tools for permanent renewal of water in each nation, through small water cycle restoration. The PAPs will become a greater contribution of primary importance to each nation's ability to both consolidate public finances and increase the efficiency of macroeconomic management, on the road to sustainability.

7.2. Economic Benefits of the GAP For Individual Nations

Nations will achieve legislative changes for the effective dynamics and timeliness of their NAPs, as a result of feedback processes provided by the GAP; such processes will ensure the full-scale implementation of the GAP, addressing a wide variety of environments and levels of ecosystem damage, and thus increase widespread value and productiveness of landscapes. Furthermore the GAP's implementation, through NAPs, will create new opportunities for products and services, thus providing new jobs and decreasing unemployment levels nationwide.

As a result of implementation of the NAP Program in each country, rainwater will be retained in the landscape, resulting in effective preventive measures to reduce the risk of flooding and drought, and mitigate climate change; the retained water will also, in many cases, become a critically important resource for increased agricultural, urban and commercial usage; these opportunities can be further developed and promoted by governments, public institutions, and private business and civil sectors. Depending on the type of landscape in which the specific projects of the NAP will be implemented, rainwater will be retained in revitalized regions through various accessible, effective, and multifunctional methods based on renewable natural resources. The first realization is that existing natural areas, particularly wetlands must be preserved or restored, including diverse native plant, animal, fungal and

[33] Long-term operation and maintenance of functionality of all landscape works, including buildings and utilities, to reduce liabilities and risks created by corresponding integrated projects, will be an essential part, achieved by including operation and maintenance in the total cost of a project's budget.

microbial species. In landscapes heavily impacted by human activities, however, restorative interventions are needed; effective rainwater retention and benefits realized by such measures include the following:

7.2.1. In forested lands, basic measures for rainwater retention include infiltration trenches and waterbars in logging roads; simple rainwater catchments of earth, stone, and logs or brush to repair gullies; followed if necessary by replanting of harvested trees; restored forests will 1) provide a source of natural high quality drinking water[34], increasing current and future limits of economic development of large areas, both regionally and nationally; 2) increase the volume capacity of water sources, thereby increasing the energy potential of watercourses, while at the same time moderating movement of water through the landscape and thus reducing both flooding and droughts; and 3) provide far-reaching climatic benefits of forests including the cooling effect of shading afforded by the tree canopy; conversion of solar energy into latent heat[35] via transpiration, and the formation of rain clouds via the mechanism of the biotic pump[36].

7.2.2. In agricultural and rural areas, measures to increase rainwater retention include water catchments in the form of farm ponds and swales; in addition much improved agricultural methods will incorporate cover crops and no-till methods for grain, vegetable, and fruit production; holistic intensive grazing management of livestock is of particular interest for the world's pasture and natural grassland areas[37]. Such measures will 1) increase production potential of agricultural land by preventing moisture loss and subsequent degradation of the land, as well as reducing erosion and pollution, and increasing biodiversity, while providing efficient reservoirs suitable for the growing of crops and watering livestock; 2) economically strengthen agricultural activities by increasing production, as well as diversification, for example by using created farm ponds for raising aquatic flora and fauna; and 3) create an attractive environment for economic development of the countryside for agro-tourism and educational programs.

7.2.3. In urban landscapes and for road infrastructure, rainwater retention can be achieved by use of innovative practices, such as green roofs, rain gardens, vegetated swales, rainwater storage tanks, and other bio-technical systems for conserving water necessary for municipal services, such as fire fighting and road cleaning; and integration of other innovative approaches to water management, for example by sophisticated and highly effective biotechnological municipal wastewater treatment. Such measures will be an effective means to 1) achieving economically feasible measures for climate restoration, such as cooling of high temperatures induced by heat islands in intensively developed environments typically made arid through extensive impervious surfaces, 2) reducing flooding and pollution related to the rapid flushing of stormwater over impervious surfaces and via storm sewers into rivers, and 3) increasing vegetated green areas for increased aesthetic, health, and recreational value for urban dwellers, as well as opportunities for local food production.

7.2.4. Particularly in arid and desertified regions of the world, all of the aforementioned measures for rainwater retention will be of further benefit by 1) increasing water and food security; 2) strengthening social cohesion and solidarity, and reducing conflict over water rights; 3) spurring economic growth, and 4) restoring native ecosystems and biodiversity.

Through practical implementation, revitalization, and conservation of rainwater in all countries, the GAP will not only directly fulfill its main objectives — building of flood prevention measures and

[34] Running Pure, an analytical study of the World Bank (November 2002), states that production of incomparably better quality potable spring water from forest ecosystems, is up to seven times more efficient than previously applied technologies based mainly on building large-scale water reservoirs.

[35] see Definition of Terms, Appendix

[36] http://www.hydrol-earth-syst-sci.net/11/1013/2007/hess-11-1013-2007.html

[37] http://www.planet-tech.com/blog/holistic-management-and-water-restoration

reducing climate change risks — but will also create specific secondary social and economic benefits, incentives for innovation and demand for new technological products and services, thus creating long-term opportunities for higher employment and economic growth.

Farsighted strategic thinking and targeted support of innovation, and introduction of new processes and products in the field of efficient use of recovered rainwater from restored small water cycles, presents a unique opportunity for businesses and investors to establish themselves in a sector which has prospect of dynamic growth[38] in a global context. In coming years, technology companies in this sector could create for themselves a significant competitive advantage in the global economy, at the time when knowledge, skills, technology, technical solutions, machinery and production equipment and related services of the GAP will be in high demand. Markets will grow in the economies of developed nations that already have high concentrations of intensive urban areas (Europe, USA, Canada, Japan) as well as in markets in economies with large industrialization potential (China, Russia, India, Argentina, Brazil, countries of the Balkans). Extraordinary demand for products of this sector can already be observed in the countries of the Middle East (Saudi Arabia, Israel, Turkey), North and South Africa (Algeria, Morocco, Egypt, Libya and South Africa) and Australia. The markets of all countries will provide sufficient business and investment opportunities in the mid-term as a result of their intensive urbanization and insensitive construction of industrial and transport infrastructure in the recent past.

An essential part of the GAP, therefore, will be projects that activate innovative thinking and use professional human potential emanating from universities and academic and public research institutes, in partnership with business professionals. With effective formation of productive technology teams, multi-sector contractual partnerships will increase a synergy for efficiently functioning technology as an effective tool for formation of national and international technology firms, and their successful entry in the competitive international market. Technological aspects of rainwater management (RWM)[39] will therefore create unmatchable opportunities for utilizing the creative potential of universities and research institutions in conjunction with the private industrial sector.

Especially in the case of young university students, both the GAP and NAPs will combine use of technical equipment and academic learning, through student design and development teams. Through the submission of graduate projects of the programs, opportunities will be created for effective use of the students' expertise, knowledge, and undisputed creative potential, with highest priority to be granted in those countries where youth unemployment exceeds 20%.

7.3. Human Potential and Its Activation

Human resources and use of professional potential are decisive for the success of any human endeavor. The GAP, as a temporary, challenging program with a global reach, has highly important ramifications for social behavior in these troubled times. Support of the global GAP community can not only restore rainwater to small water cycles, but may substantially contribute to recovery of global climate as well as social and environmental security in all corners of the world; the GAP provides an opportunity to create more than 100 million jobs. The GAP will therefore specifically focus, through integrated implementation, on activating human potential, such as expertise, knowledge and skills. Activation of human potential, and the correct setting of incentives in each country, will undoubtedly be one of the most important, but also the most complex, challenges of management of NAP Programs in each country.

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[38] For example ,in the US market a number of companies offering innovative products and services, particularly for the urban green infrastructure (green roofs, rain gardens, etc.) are already established.

[39] Rain Water Management (RWM) - Management of rainwater for permanent renewal of water in small water cycles, for flood prevention, and for reduction of land dehydration and other risks of global climate change.

For further elaboration and assurance of the efficient utilization of water, energy, production and commercial potential of forested, agricultural, urban land, and particularly arid regions of the world created by the program, and for the necessary activation and use of professional human potential, it is necessary, while strictly respecting the ecosystem approach of permanent recovery of water in landscape ecosystems, to create, through legislative process, legal rules for 1) a system of economic incentives for nationwide rainwater retention in all countries; 2) targeted efficient allocation of these economic incentives for investors, operators of water retention systems and manufacturers of sophisticated technologies, and innovative technical solutions for enablement of the necessary rainwater retention; and 3) a motivating and effective macroeconomic method of time allocation of the stimuli and incentives for rainwater retention, leading to a timetable of operation.

At the level of the United Nations, a resolution for permanent renewal of rainwater in small water cycles needs to be approved, and an institute of the UN High Commissioner for implementation of the GAP needs to be established. The institute of the High Commissioner will launch the implementation of the GAP intervention in communication with global and continental institutes. The dynamics of current global issues and international conflicts imply that GAP implementation at the global level will start immediately after the Climate Change summit in Paris in December 2015.

To ensure the implementation of the legislative process as specified in section 7.3, for the execution of actions, activities, and works that make up its contents, and to implement necessary legal and expert analysis, a team of professional and experts needs to be established in each country. The dynamics of the GAP require and assume that the above legislative process of economic incentives will begin in 2016 in individual countries.

Atul Pagar photo

INDIA: Darewadi project, 2012. Watershed development treatment (continuous contour trenches and tree plantings) for rainwater retention and soil conservation. The watershed treatment was completed in 2002. See Watershed Organization Trust at www.wotr.org.

8. MACRO ECONOMIC BENEFITS OF THE GLOBAL ACTION PLAN

Global recovery of small water cycles and climate change through rainwater conservation and retention in damaged ecosystems, and the overall revitalization of the landscape creates direct 1) financial and 2) overall macroeconomic benefits. The objective of the GAP is to create cyclical retention of rainwater at a volume capacity of 760 km^3 in the period from 2015 to 2025. Depending on available funding, the maximum implementation period of the program is in the range of 10 years.

The cost of a volume of 1 m^3 of conserved water under the program will be a maximum of $4 (US dollars) from public funds. The total cost of the program, to build the established cyclical water retention capacity during the period of implementation of the program, will reach approximately $3 000 000 000 000[40]. Implementation of the GAP and its economic multiplier effects will result in overall macroeconomic benefits which will, undeniably far outweigh the costs of the program.

8.1. Financial benefits of the program

The main factor that determines the high macroeconomic effectiveness of the GAP is that the program, by building the established cyclical retention capacity of rainwater with the volume of 760 km^3, creates simultaneously:

(1) effective protection against floods, droughts, and other risks on all continents, by achieving a cyclic capacity of water retention volume of 1 000 km^3;

(2) increased high-quality water resources with a total annual contribution that is equal to at least the minimum volume of built cyclical water retention capacity[41]. Based on the calculation of the yield of new water resources, this will achieve at least 30 000 m^3 per second.

Other important sources of macroeconomic benefits of the program are financial benefits from the multiplier effects of GAP.

8.1.1. Financial benefits from direct implementation of the GAP

Synergistic effects of the program from the simultaneous development of preventive measures against floods and other risks, together with the formation of new high-quality water sources, using innovation technology from the rainwater management (RWM) sector, will achieve:

(1) at least five times more efficient use of financial resources when compared to previously applied technology in the acquisition of water resources;

(2) at least ten times more efficient use of financial resources in comparison with the building of large-capacity water reservoirs for the acquisition of new water sources. Taking into account the social costs of acquiring new water sources, the program retrieves ten times more water resources than current methods of investment in water management.

8.1.2. Financial benefits of multiplier effects of the GAP

The strongest side of the program lies in the creation of multiplier economic effects, of which detailed

[40] The numeric representation of the macro-economic benefits and costs of GAP listed in this section are based on cautious, conservative techni cal and economic calculations obtained in Slovakia in 2010-11. The values are not time discounted. Detailed calculations of macroeconomic efficiency will be an indispensable part of any NAP at national level.

[41] Technical calculation, based on a minimum level of efficiency of the transformation of the volume of retained water to built volume of water source, is made on the basis of projects that were actually implemented, while the achieved efficiency of water retention system of programs for creating water sources will be carefully evaluated in comprehensive specific program projects.

specifications are given in Section 7.2, and in macroeconomic benefits which consist primarily of permanent creation of new jobs and tax revenues from sales generated by the technology sector RWM, and by other economic activities created by the GAP. Even in the first stages of its implementation, the program will immediately create jobs, especially for the long-term unemployed. It will also generate employment opportunities for less-skilled workers who are suited to physical labor, in forestry and agricultural activities in rural landscapes.

Depending on the scope and dynamics of implementation, the GAP will allow creation of up to 100 million jobs during the intensive implementation period (2016-2025). Jobs will include working in the area of building landscape structures for water conservation, technical solutions for rainwater conservation, and establishment of a system for increasing the retention capacity of damaged ecosystems. The employed will work directly in the damaged sections of each country.

Following the establishment of rainwater conservation systems, maintenance of systems necessary in order for them to maintain their functionality will create a minimum of 15 million permanent jobs. Furthermore, large major employers may gradually evolve into technological, production, trade and service companies in the RWM sector, due to increasing momentum from comprehensive implementation of the GAP. The program will thus create business opportunities as well as jobs for professionals, highly skilled workers and innovative managers. The introduction of new technologies will provide opportunities for their implementation and operation, as well as the subsequent provision of related services. A total estimated 12 million new, permanent job opportunities will be created.

The GAP will jumpstart the restoration of agricultural areas of countries and regions that have lost their productive potential. We estimate that over the course of ten years soil fertility will be increased on more than 5 million km^2, which will have a major impact on global food security; this will in turn create more than 100 million jobs in the poorest regions of the world. At the same time, food supplies will be increased for more than 500 million people who currently suffer from hunger. The realization of the GAP would also decrease water shortages for more than 1 000 000 000 people.

Through the GAP, major revitalization of withered countries through forest regeneration will occur. Reconstructed countries also will valorize in a way so that less developed countries that are poor in terms of food, water and economy can be on the path towards sustainable prosperity. The macroeconomic benefits of the GAP go beyond monetary values. Current civilization has little experience with what macroeconomic benefits, for example, the restoration of soil fertility can bring; therefore it will be tested on pilot projects as defined in the chapter 5.2.

At the time of dynamic growth and permanent establishment of technology companies in different market segments, the RWM technology sector and other economic activities created by the program will generate tax revenues arising from their sales in addition to the macroeconomic benefits from increases in job opportunities.

Assuming a total return of RWM sector during the period of middle life sector, a scale equivalent to 2.5 times the cost of the program, the aggregate tax revenues of the RWM sector will achieve minimum amount of $2 000 000 000 000.

8.1.3. Total financial evaluation of macroeconomic efficiency

As follows from the economic calculations mentioned in the previous sections, the overall macroeconomic financial benefits of the program safely cover the total cost of the GAP in the period of a maximum of 10 years commencing with the creation of specified cyclical water retention capacity. Furthermore, it is also clear that the implementation of the program, in the long-term, creates a global macroeconomic effect of at least $10 000 000 000 000. This amount represents savings of global funds that would be needed to address the solutions for water supplies through traditional technology.

Through traditional methods and technologies, it is not possible to reach an equivalent level of technical efficiency and effectiveness of macroeconomic systems, water conservation, innovative technology and other technical solutions for the rehabilitation of water in small water cycles, that is possible by utilizing the GAP.

8.2. Overall Benefits of the Global Action Plan

The world has one strategically valuable natural resource: water, and one talented, but yet under realized, intangible resource: human potential. The GAP opens up opportunities for the optimization of human potential through new technologies and new products and services. It creates opportunities for efficient, yet environmentally sensitive and cautious usage of this blue planet's potential, and the start of restoration of damaged landscapes by the realized return of water to small water cycles.

The economic potential of all the earth's resources can be multiplied by the synergy that is created and supported through creation of the GAP, through its strategies based on the processes of the natural world combined with human potential. The opportunities for innovation in the rainwater management sector will generate a desirable and creative economic growth and a significant contribution to long-term solutions to global problems, including desertified and degraded lands, lack of clean water, and the resultant poverty and civil unrest.

The total contribution of the GAP could in fact be incalculably higher, by creating environments worldwide in which it will be possible to safely work, operate a business, and enjoy a good quality of life. Benefits which statisticians do not currently include in GDP growth figures, will include massive relief from water stress and a major increase of financial investment by those who recognize the vast opportunities for new business.

Thus a global economy based on local renewal of water cycles provided by the GAP will create conditions for improving the quality of life, even in the parts of the world where there is presently a dire lack of water and food. Vast areas of previously arable land have become dry and barren through humanity's mismanagement of rainwater over the past decades and even centuries. Restoring these lands, by recapturing rainwater into the earth and local small water cycles, will inexpensively ease the great burdens of everyday life suffered by the majority of the world's population. The GAP will provide abundant water resources to support not only the vast biodiversity of healthy ecosystems but also increased human populations. Women, however, who are freed from the burden of sheer daily survival will likely become better educated and pursue livelihoods beyond bearing children, which would lead to decreased birthrates and increased education for their children, creating an upward spiral out of poverty.

Lacking water, very little improvement of ecological degradation, poverty and strife is possible; with water, everything is possible. The Global Action Plan can lead the way to water security for all, and renewed hope for much increased peace and prosperity, for a revitalized world emerging from restored lands and climates. Thus we invite all stakeholders, citizens of all nations, of all walks of life public or private, to join in a cooperative effort to help restore life-giving small water cycles to Planet Earth.

Definition of terms used in the Global Action Plan (GAP)

Biotic pump - a theory emphasizing the role of forests in climate. Due to the high leaf area index, natural forests maintain high evaporation fluxes, which support the ascending air motion over the forest and "suck in" moist air from the ocean, which is at the heart of the biotic pump theory of atmospheric moisture.

Heat islands - land areas (usually urban) that are significantly warmer than surrounding rural areas due to human development, such as paved surfaces, rooftops, and removal of vegetative soil cover.

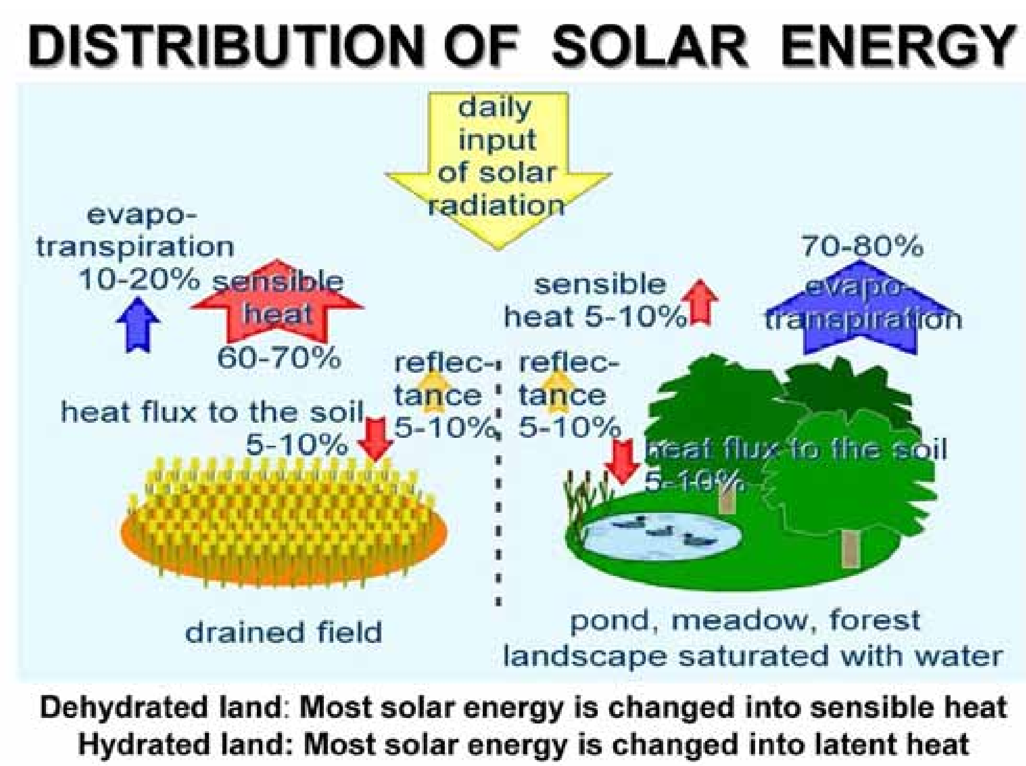
Latent heat - the heat required to convert a solid into a liquid or vapor, without causing a change of temperature.

Sensible heat - heat exchanged by a body or thermodynamic system that changes the temperature, and some macroscopic variables of the body, but leaves unchanged certain other macroscopic variables, such as volume or pressure.

Mountain massif - A large mountain mass or compact group of connected mountains forming an independent portion of a range. A massif often consists of rocks that are more rigid than the surrounding rocks.

Small water cycle - a closed circulation of water in which water evaporated on land falls in the form of precipitation over this same terrestrial environment. Small water cycles also occur over seas and oceans[42]. As opposed to the **large water cycle**, which is the exchange of water between ocean and land[43].

Transpiration - the evaporative process by which moisture is carried through plants from roots to leaves, where it changes to vapor and is released to the atmosphere.



[42] New Water Paradigm - Water for the Recovery of the Climate, Municipalia, 2007, www.waterparadigm.org, p 17
[43] New Water Paradigm - Water for the Recovery of the Climate, Municipalia, 2007, www.waterparadigm.org, p 16

Water, Vegetation and Climate Change - Košice Civic Protocol

26. NOVEMBER 2009, *TELE*DOM, KOŠICE, SLOVENSKO

Contents:

Košice Civic Protocol on Water, Vegetation and Climate Change

The uniqueness of the Earth from the climatic point of view is the result of a combination of favourable conditions, in particular the evolution of life over the course of several long geological periods.

It was above all micro-organisms and later also plants which over billions of years changed the physical and chemical environment of our planet, optimizing and later stabilizing certain parameters, including the climatic ones such as temperature and humidity, and the chemical composition of water, soil and the atmosphere. In this way they created the necessary conditions for the emergence of life as we know it today.

The living world influences the climate mainly by regulating the water cycle and the huge energy flows which are closely linked with it.

Natural ecosystems also develop in the long term towards the stabilization of closed cyclical processes (e.g. the water or carbon cycles), whose central medium is water and which efficiently manage solar energy with minimum material losses.

Transpiring plants, especially forest growth, demonstrate especially efficient water management. They work as a kind of biotic pump, causing humid air to be sucked up out of the ocean and transferred to dry land. Forests in the hot and moderate zones always appear cooler during sunny periods (particularly on infrared satellite photos) in comparison with their unforested surroundings. These and other aspects make for perfect climate-forming systems on the Earth.

For millions of years the self-regulating mechanisms of the biosphere have proven capable of correcting a wide range of unfavourable effects (e.g. fluctuations in solar energy, meteoric impacts, volcanic activity and the constant emergence of carbon from the depths of the Earth), which have continually disrupted the Earth's climatic stability.

Through their activities over thousands of years, human beings have been destroying ecosystems which have the potential to actively correct those unfavourable effects. People themselves began disrupting and changing the closed cycles of nature. The combination of these effects is gradually raising them to such intensity that nature itself is not able to correct them, and in certain cases a state is being reached which is not permanently sustainable.

A prime example of opening the closed cycles of natural ecosystems is the deforestation of land, accompanied by increasingly rapid run-off of rainwater, marked acceleration of soil erosion, reduced content of organic material in the ground, and substantial reduction of its ability to hold water.

Another example of creating imbalance is the collecting of rainwater from the built surfaces of modern towns and villages and its channelling away through sewers into the rivers and the sea. This water is then lacking in that part of the land. It is lacking in the soil, the vegetation, the underground water reserves, and last but not least also in the atmosphere.

Destruction of the hydrological cycle by humans disturbs the sequestration of carbon in the soil and vegetation and by this reduces the water storage capacity of the area. Reduced water content in the ground leads to an increase in oxidation processes and to losses of organic matter. Dry periods and heatwaves reduce photosynthesis and increase the probability of incidence of large forest fires.

Draining of the land requires special attention because of its influence on local climate. The presence or absence of water has considerable impact on the distribution of energy between the two principal heat flows: latent heat of evaporation and sensible heat. If water is not sufficiently present in the land, a large part of the incidental solar energy is changed into sensible heat, and the temperature of the environment sharply rises.

Every year around 54 750 km² of the Earth's surface is urbanized. We calculate that if evaporation from this surface is reduced by 200 mm each year, then in those same areas each year an additional approx. 6.7 million GWh of sensible heat is produced.

If we apply the same reduction in evaporation to the 127 000 km² of the Earth's surface which is deforested every year, then we get a further approx. 17.4 million GWh of sensible heat being produced. This amount of heat alone in itself roughly corresponds to the annual production of electrical energy by the human population of this planet.

Enormous amounts of sensible heat originate from the land surfaces transformed into farmland or urban environments in the past. Fields and pastures and built areas on all continents together make up around 55 million km².

The flow of sensible heat released through draining of the land is locally several orders of magnitude higher than the effect (through amplification of radiation) of greenhouse gases, and greatly outstrips differences in the albedo.

These so-called "hot-plates" originating from the land transformed by humans prevent the condensation of water vapour in the atmosphere, thus causing a reduction in precipitation over these areas. They also produce temperature differences which trigger the development of climatic extremes. These phenomena in drained areas are often mistakenly ascribed to greenhouse effects.

There is a growing number of scientific articles bearing witness to the climatic impacts of extensive damage to vegetation and the natural water cycle by human beings.

It is shocking that the relevant leading institutions in the world have so far paid insufficient attention to the climatic function of the coexistence, formed over geological eons, between vegetation and the water cycle, and the human disruption of this relationship through land management.

If climate change science does not include all relevant parameters into its theories, models and scenarios, the adequacy of the science is threatened. In turn, the policy recommendation will be inadequate or even counterproductive. If water and vegetation are not properly included, a large part of human activity (land management) and its cooling/heating effects will be unexamined. This may also reduce the motivation of those responsible to undertake unpopular counter-measures.

The principal mitigating and adaptive measure to combat that part of climatic change caused by human draining of the land and/or alteration of its vegetation cover is the renewal of the water cycle (through a consistent programme of rainwater retention) and vegetation in damaged areas.

The importance of renewing and protecting the natural vegetation and water cycle is in no way inferior to any other measures for the recovery of the climate. For this reason we demand that local, regional, national and international communities devote appropriate attention to these factors.

Signed in Košice, dated 26th November 2009

Michal Kravčík, Juraj Kohutiar, People and Water, Slovakia

Jan Pokorný, ENKI, Czech Republic

Viliam Ripl, Marco Schmidt, Technical University Berlin, Germany

Introduction

Water and vegetation are of primary importance for the global climate. Human activities cause large deforestation, desertification and urbanization rates of hundreds of square kilometers daily. Unsustainable land use causes huge impacts on vegetation, water and the climate. These effects are overlooked in the common climate change debate. A group of Slovak, Czech and German activists, the authors of this civic protocol, has decided to make its voice heard and to draw attention to this problem.

The authors set out from the background of thought developed by the People and Water NGO and the Association of Towns and Villages in Slovakia, the ENKI public benefit corporation (Czech Republic) and the Technical University in Berlin (Germany). Apart from mutual friendship, what links the authors is their interest and several years of work spent in investigating the impacts of human activity on the water cycle, vegetation and changes in energy flows in the land, which all have their effect on the climate. The authors are in regular contact with both scientific and expert communities, and they are aware of the growing amount of research material which, in the shadow of popular theories, draws attention to those aspects of climate change which are also the subject of this protocol.

The text of the protocol itself is not exhaustive. It makes no claim of establishing the ultimate truth. The authors share the awareness that "knowledge is proud that it knows so much; wisdom is humble that it knows no more" (W.Cowper). The attached texts are intended to draw attention to the comprehensive nature of climatic change, paying homage to the considerable perfection of natural systems, but also criticizing human arrogance which does not respect the holistic character of natural processes.

The immediate impulse for compiling this protocol is the approaching summit on climate change in Copenhagen, in particular the tendency in the preparations for this conference indicated by the negotiation text, which, despite protests from some professional organizations, ignores water and vegetation as essential components in the Earth's climatic system. In this sense the attached text is an urgent appeal to remedy this situation, to have water and vegetation placed at the centre of attention of the responsible institutions at the summit and after it.

Our Blue Planet

Planet Earth is unique in many different aspects, its climate being one of them. This is a result of its optimal location in our solar system, its geographical features, its bounteous occurrence of water and the evolution of both the living and non-living natural world found on it. The synergy of all of these and many other circumstances allows for the existence of complex and mutually sustaining ecosystems, and in particular mankind, which is, thanks to his intelligence, the steward of all creation.

The optimal distance of the Earth from the Sun means that our planet does not suffer excessive heat like neighbouring Venus, or an excess of cold like Mars, our neighbour on the opposite side of our orbital path. The proximity and gravitational force of the giant planet Jupiter protects the Earth from frequent impacts of comets and asteroids and the catastrophic consequences such impacts would have on our climatic system.

The relative stability of Earth's orbit, the incline of the planet‘s axis or the speed of its rotation also appear to be optimal from the viewpoint of maintaining a small difference in temperatures. The size of our planet seems be just right from the standpoint of sustaining an atmosphere sufficient for the further balancing of temperatures. The amount of water present on Earth, divided into its latent states, is large enough to fulfil ecological and climatic functions, but not so large that it would flood the continents.

In such a short text, it is difficult to pay sufficient homage to the gift of water. Water makes our planet unique among the planets: it provides it with its characteristic appearance and beauty when seen from space and up close; it is the blood and lymph of functioning nature. But where did the water on Earth come from? Scientists are not in agreement whether a substantial portion of water on Earth is the result of its original composition, whether it originated from meteorites or comets which bombarded the Earth during the early stages of its development, or whether it is a result of biochemical reactions of elemental forms of life.

The last of the mentioned hypotheses credits prokaryotic bacteria, which rank among the first forms and pioneers of life on Earth, as probably causing the biochemical transformation of primitive seas of sulphides into seas of water. We thus arrive at living forms which not only adapted genetically to the existing conditions on our planet but also actively influenced them during the process of evolution.

An example is our atmosphere, which a billion years ago contained practically no oxygen, but thanks to evolutionary changes to the biota, underwent changes and stabilisation of its composition roughly in its contemporary state. Another example is inorganic carbon, which is constantly entering the biosphere from the Earth's crust (particularly through volcanic activity). With the mentioned inputs during the past billion years, the concentration of CO_2 in the atmosphere should be an order of 1000 times higher in comparison with today's state (as it is, for example on Mars). We can thank biotic regulation, however, for the fact that the deviation has shifted maximally within a range of only ten times the average value.[1]

It is impossible to resist the idea that the direction of the biota‘s influence on the environment was not chaotic, but at first headed toward its optimalisation and later toward the stabilisation of certain optimal parameters. Among the most prominent of these mentioned environmental parameters is the average temperature of the Earth, which over the past roughly 4 billion years has changed, in terms of suitability for life, only within a very narrow range of ± 5ºC of the present average.[2] The temperature has also remained stable despite a roughly 30% increase in solar radiation during the geological existence of our planet.

In relation to the mentioned facts, some authors began to compare the complex Earth to a gigantic living organism (the Gaia theory). Without devoting ourselves to the philosophical-religious implications of similar considerations, it is difficult to hide one's surprise and admiration at the discovery of other aspects of the symbiotic functioning of the complexes of living and non-living nature. These, with the help of water as the central medium, are evolving towards the creation of closed cyclical processes, which demonstrate the effective management of energy and a minimal loss of mass, which contributes to their growing stability and ecological sustainability.[3]

Though, the opening of the closed cycles of nature by the activities of mankind is beginning to reach such a degree that the self-regulating mechanisms of nature are no longer sufficient to correct them. Mankind can learn from its own mistakes. It is slowly beginning to recycle some materials, but has still hardly matured to the stage of recycling those most important components for sustaining life, which are water and vegetation. The larger part of the remaining

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[1] Gorshkov, V.G., Gorshkov, V.V., Makarieva, A.M., 2000: - *Biotic Regulation of the Environment: Key Issue of Global Change.* Springer-Praxis Series in Environmental Sciences, Springer, London;

[2] ibid

[3] Ripl W. - *Water: the bloodstream of the biosphere.*2003: Philosophical Transactions of the Royal Society London B 358, pp.1921-1934

text is devoted to the current impacts of mankind‘s activities on the climatic system of the Earth by means of water and vegetation as well as how mankind should correct this in order to deserve the epithet of ‘rational being’.

Some Factors in the Earth’s Climatic System

Climatic change is either a long-term significant change of the current trends in the weather for a particular territory or for the Earth as a whole. Changes in the climate result primarily from changes in the energetic balance on Earth. Changes in the energetic balance can have a number of causes which originate within or outside the Earth‘s climatic system.

Among the reasons for changes in the amount of solar energy received by our planet are a number of astronomical influences such as cyclic changes in the shape (eccentricities) of the Earth’s orbital path around the sun, changes in the tilt of the Earth’s axis (axial tilt) and its precession (amplitude). These alternate in 96,000-year, 41,000-year and 22,000-year intervals known as the Milankovitch cycles. They are expressed particularly by the roughly 100,000-year cycles of ice ages, but their intersection also causes warmer and cooler periods within them.

Changes in solar activity are an additional factor potentially influencing the climate on Earth. The best-known are the 11- and 22-year cycle in the number of sunspots manifested in the solar radiation falling perpendicularly on the upper edge of the atmosphere. A smaller number of sunspots can be associated with a decrease in solar activity. The change in the flow of solar energy reaching a surface on the external edge of our atmosphere, that is, the solar constant (1367 W/m^2), which is paradoxically not a constant, is associated with the elliptical shape of the Earth’s orbital path around the Sun and with solar activity. This changes infinitesimally, but, for example, the same statistical periodicity of a number of climate phenomena (temperatures, precipitation, etc.) such as the periodicity in the occurrence in sunspots, signifies a possible mutual connection.[4] This connection, however, has thus far not been clearly interpreted.

An additional category of factors influencing the climate on Earth is opened by the hypothesis for the extinction of the dinosaurs which says that it was caused by the fall of an asteroid roughly 10 km in diameter some 65.5 million years ago. Dust particles dispersed into the atmosphere by the fall of this and other celestial objects could have dimmed the sun and, for a number of years, limited photosynthesis and causing a long-term decrease in temperatures. The eruption of volcanoes can have a similar effect as the fall of large meteorites. Volcanic eruptions are known which spewed emissions as high as the stratosphere, where they lingered for a long time, and where their effects resonated for a number of years in the form of longer and cooler winters, hailstorms and droughts.

Aside from the total energy balance on Earth, the structure of energy flows also depends on its climatic system into which solar energy is channelled. Factors of both natural or anthropogenic origin influence the structure of energy flows. An example of this first category are orogenic processes. Mountains and mountain ranges significantly influence atmospheric currents, especially those which are orientated north-south, because the influence of the Earth’s rotation and the Coriolis effect determine the predominating east-west direction of winds. Mountains and mountain ranges also significantly influence temperatures, the drainage of water from a region, their vegetation, evaporation and precipitation. Possible snow cover changes the

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[4] /http://www.global-climate-change.org.uk/3-2-1-3.php/

reflective power (albedo) of a surface and with it the amount and structure of solar energy in a region‘s system.

Plate tectonics can also be seen as being natural climate factor. It determines, over a very long time scale, the shape and location of the continents and have a similar fundamental influence on the dynamics of climate with regard to the differential warming of the seas and land, or on the climatic impact of warm and cold ocean currents.

Another large group is made up of the influence of changes in the composition of the atmosphere. In the atmosphere a number of gases are found which have these three basic features: radiation activity, spatial arrangement and duration period. By the term radiation activity of gases we mean the absorption of radiation at some important part of the wavelength spectrum. The effect of growing concentrations of such gases on the stabilisation of higher average temperatures in the ground layers of the atmosphere is often labelled as “radiation amplification“. On the other hand, the growth of the concentration of some aerosols can have the opposite effect, that is “radiation damping“. The value of radiation amplification through the influence of anthropogenic emissions in the year 2000 in comparison with the state prior to the Industrial Revolution was estimated to be 2.43 $W.m^{-2}$, and of radiation damping at 0 to 2 $W.m^{-2}$.[5]

Through its activities mankind is influencing the composition of the atmosphere and thus the climate not only through the emission of gases which are commonly called greenhouse gases, but especially through changes in vegetation and the circulation of water and along with this, very closely related flows of energy. We will devote ourselves to these aspects of human activities in the coming sections.

Water as a Climate Factor

Water has a number of exceptional thermoregulatory characteristics. Besides the fact that at temperatures common on Earth, water occurs naturally in all three states, its most important thermoregulation characteristics are that it has the largest specific heat capacity (the ability to receive thermal energy) among commonly occurring substances and the largest consumption or release of large amounts of thermal energy upon a change of state.

We have already mentioned briefly the role of the oceans in the section on the parameters of Earth’s climatic system. The high specific heat capacity of water ($cp = 4\ 180\ J\ kg^{-1}K^{-1}$) in the oceans means that temperature fluctuations in the oceans, when compared with land in the course of a day or year, are a great deal smaller (for example, specific heat capacity of soil is $cp \approx 800\ J\ kg^{-1}K^{-1}$). This characteristic of water, in combination with the gigantic amount of it stored in the seas and oceans, represents a great stabiliser of temperatures on Earth.

The greatest portion of the solar energy absorbed by the surface of the Earth is absorbed by oceans in the tropics. The climates in the tropics and subtropics are dominated by a mechanism dictated by the intensive absorption and dissipation of solar energy known as the Hadley circulation, which determines the running trends of winds, cloudiness and precipitation in this zone. The difference in the warming between the tropics and polar regions and the differential warming of the sea and land ranks (along with the Earth’s rotation) among the primary reasons for winds contributing to the balancing of temperatures between regions of different geographic latitude.

[5] Lapin M. - Briefly on the theories of the climate system on Earth, particularly in connection with changes in the climate; modification of the professor’s inauguration lecture from 20. 9. 2004, Internet

The differential warming and saltiness of water in the oceans, together with other factors again contributes to the flow of ocean currents, which carry heat energy thousands of kilometres, and especially in the case of the north-south flowing between the Equator and the poles, influences the temperature of large regions. This demonstrates that a possible small change in the structure of ocean currents can have far-reaching effects on the climate over great parts of the Earth.

The fate of solar energy significantly depends on the presence of water in the region on which it falls. The presence or absence of water significantly influences the distribution of energy between two main flows of heat: latent and sensible heat. As the names themselves suggest, sensible heat is accompanied by an increase in the temperature which we feel. Latent heat, in our case the latent heat of water evaporation, is not accompanied by an increase in temperature. It is the amount of energy which water must absorb in order to transform into vapour of the same temperature. The evaporation of water, then, consumes heat, by which the surface of the earth is cooled, and this does not involve a small value. The specific latent heat of evaporating water under normal pressure and a temperature of 25 °C is 2243.7 kJ/kg. This same amount of heat is released later during condensation of water vapour in colder places, mainly during formation of clouds.

Water can change into water vapour and cool the surroundings in a region only if it is present there. If it is not present, a large portion of solar energy is changed into sensible heat and the temperature of the surroundings sharply increases. While in a dried region the majority of incoming radiation changes into sensible heat, in a country sufficiently stocked with water, most radiation goes into latent heat of water evaporation, and only a much smaller portion of solar radiation is changed into sensible heat.[6]

With evaporation water gains high mobility, thanks to which it is able in relatively large volumes to quickly shift in both horizontal and vertical directions. The surface of a well-watered region is cooled via evaporation in the case of intensive solar radiation. Water vapour, which ascends higher into the atmosphere, condenses under the influence of cold and thereby transfers its thermal energy. The repetition of this process resembles an ingenious air-conditioning device.[7]

Cloudiness limits the entry of solar radiation into the atmosphere and to the surface of the Earth. There is a substantial difference in the amount of solar energy reaching the Earth's surface when the sky is clear and when it is overcast. Clouds reflect a portion of shortwave solar radiation, thus limiting its entry into the atmosphere and the Earth's surface, and thus protecting the Earth from overheating. They also capture, however, part of the longwave (thermal) radiation from the Earth which has a warming effect and which would otherwise escape into space. This greenhouse effect from water vapour greatly predominates over the similar effect of all other so-called greenhouse gases. The atmosphere on Mars contains 95% CO2, and the atmosphere on Earth 0.039%. Despite this fact the greenhouse effect on Earth is six times greater than on Mars. This difference, also when calculating for differences in the density of the atmosphere on both planets, can be explained only by the existence of water vapour and clouds on Earth.[8] Temperature differences on Mars are more dramatic than they are on Earth. Despite the negative image created by mass communications media in connection with the battle against greenhouse gases emissions, the greenhouse effect is vitally important for the stability of climatic interactions on our planet.

[6] Kravčík M., Pokorný J., Kohutiar J., Kováč M., Tóth E. - Water for the Recovery of the Climate – A New Water Paradigm, Krupa Print, Žilina, 2007,

[7] Ibid

[8] www.bioticregulation.ru/ques.php?nn=24&lang=en

Water evaporation is the most important energy transformation on Earth. It functions as the main buffer to the gigantic amount of solar energy that is falling on our planet every moment. Thanks to the evaporation of water, solar radiation arriving to Earth is transformed into latent heat and so moderates the accumulation of sensible heat at the Earth's surface. The draining out of a land has as a consequence the release of an extremely large amount of sensible heat into the atmosphere. A drop in evaporation by one litre per square metre (700 Wh) per day initiates the flow of sensible heat several tens times higher than the effect of greenhouse gases (radiational amplification) from the Industrial Revolution.[9]

Water further moderates temperature differences between regions with a different altitude or geographic latitude, between oceans and land, between day and night, between the annual seasons and, in connection with the melting of glaciers, even between ice ages and interglacial periods. The less water there is in a region and in the atmosphere above it, the weaker the effect of balancing out of temperatures, and thus swings in temperature and the weather are more extreme. This is the case in deserts on Earth and other planets (compare, for example, the temperature differences on the Moon, which range from -240ºC to +120ºC).

Vegetation as a Climatic Factor

Through active regulation of waterflows, terrestrial ecosystems can greatly influence the distribution of solar energy mentioned above into two main areas: sensible heat and latent heat. Vegetation reflects some of the incoming solar radiation, transforms (dissipates) some through water evaporation, changes some into sensible heat, a part warms up the soil and, through photosynthesis a relatively small part is stored up in biomass.

Together with the absorption and photosynthetic fixation of carbon dioxide, growing fibres also store water. Growing biomass may have a water content up to 80-90%. As well as for fibre growth, vegetation also needs water for evapotranspiration. Values of evapotranspiration vary according to geographical zone, altitude and other factors. About 3 litres of water per square metre are evaporated in average in conditions of a mild climate (Slovakia) on a sunny day (if there is enough water in the ground), which equals 2.1 kWh (7.5 MJ) of latent heat. Evapotranspiration is a dynamic process primarily dependent on the input of energy and availability of water.

Plants differ greatly in their ability to evaporate/transpire water. In the temperate zone the transpiration of coniferous trees is in general lower than that of deciduous trees. Wetland plants have the highest level of transpiration, some, if they have enough water, being capable of evaporating more than 20 litres of water per square metre in the course of one sunny day.[10] In cultivated land evapotranspiration is, during sunny days, usually limited by a lack of water, which means that the actual levels of transpiration are much lower than they potentially could be.

Transpiring plants, especially trees, are one of the Earth's most wonderful air-conditioning systems. Imagine a large, free-standing tree, its crown with a diameter of 10m. In the course of one day, 450 kWh (4–6 kWh/m^2) of solar energy can fall onto its 80m^2 of crown, some of

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[9] Pokorný J., Water and the transformation of solar energy on land – closed cycles in ecosystems of land and river basins, Životné prostredie, 2009 (in print)

[10] Kučerová A, Pokorný J, Radoux M, Němcová M, Cadelli D, Dušek J - Evapotranspiration of small-scale constructed wetlands planted with ligneous species, 2001

which is reflected back, some of which goes into heating the soil and some of which is transformed into heat. If the tree is well supplied with water, up to 400 litres of it can evaporate in one day, 280 kWh of solar energy being consumed to convert the water from its liquid state into water vapour. This amount of consumed energy is the difference between the shade of a tree and the shade of a parasol with the same diameter. In the course of a sunny day, such a tree cools with the power of 20 – 30 kW, a power equal to 5 air-conditioning units.

Unlike manmade air-cooling equipment, a tree is “fuelled“ only by solar energy, is made of recyclable materials and requires minimal maintenance. The outflow of water vapour is regulated by millions of air pores which react to the temperature and humidity in the environment. What is important is that solar energy stored in water vapour is transferred further and only released when the vapour condenses in cooler places. This way trees help regulate temperatures both in time and space, unlike fridges or air-conditioners, which emit heat into the area around them. In contrast to fridges and air-conditioners, trees also work in absolute silence, absorb noise and dust.

Most people will have experienced the pleasant coolness of a dense forest on a hot summer’s day. A temperature inversion (a higher temperature in the crown of the tree than on the ground) during the day helps retain almost 100-percent of the air humidity above the surface of the soil. The balance of humidity and temperatures under the crowns of trees is directly proportionate to the density and height of the vegetation.[11] This is another reason why healthy dense forest is less susceptible to fire. Forest management of water beneath the crowns of trees is so effective that the trees can afford to evaporate large amounts of water from their crowns and so cool the air above them. On infrared satellite images, taken on a sunny day, forested land is visibly cooler than unforested land alongside.

In sparser forest and open (for example, grassy) ecosystems, the same temperature inversion does not arise. The night-time temperature inversion above the crowns of the trees and above open, unforested ecosystems often leads to condensation and fog. Part of this gravitates down to the ground and in closed forest ecosystems, unlike in open areas, this part can remain in the form of moisture for the whole day.[12] The water microcycle which in our conditions is manifested by dew drops on grass or on needles is, according to the German hydrologist W. Ripl, the most abundant and widely occurring sign of water circulation in vegetation and the most important stabilizing process on mainland. The cycle dissipates solar energy with great efficiency and without negative side effects, such as dehydration, desertification and soil erosion.[13]

Russian scientists, V. G. Gorshkov and A. M. Makarieva have come up with a new, very interesting interpretation of the relationship between forests and precipitation. Having examined the correlation between levels of annual rainfall in unforested regions in various continents (savannah, steppes, semi-desert) and their distance from the sea, as well as of rainfall in naturally forested areas, they came to the striking conclusion that in unforested parts of continents annual rainfall gets rapidly lower the further away the regions are from the sea, whereas in areas covered by natural forest, not only do levels of rainfall not decrease but in some cases they rise, even over distances of several thousand kilometres.[14]

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[11] Makarieva, A.M., Gorshkov V.G., Li B.L., 2006: Conservation of water cycle on land via restoration of natural closed-canopy forests: implications for regional landscape planning. Ecological Research 21, pp 897-906

[12] op.cit.

[13] Ripl W. - Water: the bloodstream of the biosphere.2003: Philosophical Transactions of the Royal Society London B 358, pp.1921-1934

[14] Makarieva, A.M., Gorshkov, V. G., 2007: Biotic pump of atmospheric moisture as driver of the hydrological cycle on land. Hydrol. Earth Syst. Sci., 11, pp 1013–1033

The above scientists have formulated the so-called 'biotic pump' principle whereby a horizontal flow of moist air arises from a region with lower evaporation and moves into an area of higher evaporation. Thanks to the greater cumulative evaporating surface of leaves, forest ecosystems during the vegetation period evaporate several times more water than open hydrous areas of the same size. Forests thus become a biotic pump providing suction of moist air from the ocean to the mainland.[15]

If evaporation over land decreases in comparison to evaporation above the sea which washes the land, the physical mechanism described above is reversed and moisture is drawn away from the land. Meadows and agricultural land, with their relatively low levels of evaporation, are unable to create the biotic pump effect and their water cycle is critically dependent on their distance from the sea and fluctuations of rain-bearing weather. There is evidence from various corners of the world which supports the above theory, evidence which undermines the long-held assumption that levels of rainfall in a region have nothing to do with the nature and quality of its surface.

Water and the Carbon Cycle

Current climate change deliberations deal almost exclusively with the role of CO_2. Though, promotion of healthy ecosystems and a well functioning water cycle should be a special concern even for those who are convinced about the dominant role of this gas in the Earth's climate system. It is because carbon cycle is closely tied to water and vegetation.

The amount of CO_2 in the atmosphere is determined by how much is emitted into the atmosphere through the burning of fossil fuels and cement production, the terrestrial biospheric flow of CO_2, which includes photosynthesis and plant respiration, the influence of fires and soil management; and finally the flow of CO_2 between the ocean and the atmosphere.

To put it simply, we can say that while oceanic biota and well functioning ecosystems on land help store carbon, disturbed ecosystems on land emit it into the atmosphere. The ability of oceans and biota in sea water to sequestrate (absorb and store) CO_2 is not measurably changing. It is however, insufficient to negate the effects of anthropogenic carbon production.

Terrestrial sequestration of CO_2 from the atmosphere is at its highest in the northern temperate zone. About 50% (approx. 1150 Gtons) of carbon supplies in the world's ecosystems are stored in forests, with the remaining 1000 or so Gtons being stored in other ecosystems such as tundra or grassy plains. In the forests of the northern hemisphere, about 84% of carbon is stored in organic soil matter.[16]

The soil sequesters carbon through its vegetation. Bare soil can hardly store carbon although it can release it relatively fast. When soil moisture decreases, the soil becomes more aerated. It leads to an increase in oxidization processes and faster mineralization of the soil's organic matter. If forest land is turned over to agriculture, carbon content in the soil usually falls by 30% or more. This loss of carbon from soil means a fall in its organic content, its fertility and its ability to retain water, one result of which are more frequent local droughts.[17]

The lack of water in soil also increases its potential to overheat, which again contributes to mineralization of organic matter. In land with a lack of water and vegetation, land which

[15] op. cit.

[16] Bierkens M.F.P., Dolman A.J., Troch P.A. (editori) - Climate and the Hydrological Cycle, IAHS, 2008

[17] Ripl W., Eiseltová M. - Sustainable land management by restoration of short water cycles and prevention of irreversible matter losses from topsoils, Plant Soil Environ., *55*, 2009 (9): 404–410

overheats, water vapour does not condense and the land suffers from a shortage of dew and steady rainfall from the small water cycle. Rain usually comes as a result of frontal disturbances, with the rainwater running off very quickly because of the land's low water-retaining capacity.[18]

From the preceding text it emerges that the interaction of the carbon cycle with the hydrological cycle plays an important role in the exchange of carbon between land surface and the atmosphere. Annual variations in the exchange reach the levels of fossil fuels burnt by humans. Variations are primarily dependent on levels of rainfall. Droughts in the northern temperate zone have the strongest influence. Droughts and intense heatwaves reduce photosynthesis and increase the probability of destructive forest fires. In the event of disruption of the natural cycles, there is a risk of the vast amounts of carbon stored in organic matter being suddenly released into the atmosphere.[19]

Many experts believe vegetation could compensate for current anthropogenic carbon emissions. According to the Russian scientists, Gorshkov and Makarieva, it would be enough to renew natural forests on about 7% of cultivated land. As in terms of water and other matter balance, artificial ecosystems, e.g. agricultural ones, are largely destabilizing in terms of the carbon balance also.[20]

The Influence of Land Use on Vegetation and Water Circulation

Humans have been shaping the landscape since their first appearance on the planet, the intensity and extent of this shaping process varying over time and reflecting humans' different means of finding food and levels of social development. Major milestones in human evolution and the changing landscape have been shifts such as: the move from the hunter-gatherer way of life to the agricultural and pastoral one (the Neolithic Revolution); the Industrial Revolution, which meant a move from manual to machine-based manufacturing; several waves of urban revolution which were to influence the numbers of town dwellers and their quality of life; and the 20th century green revolution, which again changed the nature of agriculture. Deforestation of huge areas and their conversion to agricultural use or urban development have also had a marked effect on water circulation.

Research into lake sedimentation in northern European lakes during various phases of forestation after the retreat of glaciers about twelve thousand years ago illustrates well the role of vegetation in regulating water circulation and erosion. The 2-3 thousand year period of gradual recolonization of the barren landscape from the first pioneering plants to climax forest is first marked by high transport of surface material to the lakes, material which then gradually diminished to only a tenth of its original amount. When about two hundred years ago, people first started to destroy the vegetation covering these studied river basins in order to develop agriculture and to urbanise, the transport of surface material then increased by between 50 and 100 times compared to the optimal natural state.[21] Humans became an important factor in opening cycles of water and soil material which had hitherto been more or less closed.

What started in some parts of northern Europe only relatively recently had started in other parts of Europe and the world a lot earlier. The outstanding American paleoclimatologist, William F. Ruddiman, draws attention to the fact that human influence on the climate began about eight

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[18] ibid
[19] Bierkens et al. - Climate and the Hydrological Cycle
[20] Gorshkov V.G., Gorshkov V.V., Makarieva A.M. - Biotic Regulation of the Environment: Key Issue of Global Change. Springer-Praxis Series in Environmental Sciences, Springer, London, 2000
[21] Ripl W., Eiseltová M. - Sustainable land management by restoration of short water cycles and prevention of irreversible matter losses from topsoils, 2009

thousand years ago with the agrarian revolution which followed the last ice age. This influence, especially human liquidation of forests, was of a smaller intensity before the Industrial Revolution than today but continued for much a longer period and in total exceeded it.[22]

After the removal of forest, the water management situation is tied in with a whole chain of factors. Deforestation and reduction of the quality of forest vegetation is accompanied by an increase in the speed of rainwater run-off and soil erosion, a reduction in soil's organic material content and with it, its water retentiveness. The more dehydrated and hardened the soil, the harder it is for it to absorb the next fall of rain and the greater the surface run-off. There are several examples similar to that of the Brazilian Tocantins river basin, where, in the period from 1960 to 1995, together with forest removal and development of agriculture, river levels rose by 25 percent despite the fact that rainfall did not increase during that time.[23]

Another factor in the drainage of large expanses of land are the crops grown on them. Certain edible grass seeds were ideally suited to agricultural cultivation and formed the basis of the cereal farming which was to become the most extensive food supply for mankind. In Europe, as well as in many other parts of the world lying in the temperate zone, the cultivation of wheat and barley, which are believed to be the first domesticated cereals, has been dominant since the Neolithic Revolution. These retain the quality of the annual steppe grasses from which they were first bred and so require steppe-like conditions; to grow them well the soil must first be drained. This enormous project has been one of the main causes of land drainage in the modern age.

Artificial irrigation, practised even by ancient civilizations in combination with intensive agriculture, is not a long-term sustainable solution because as we can see from examples, it leads to salination of the soil. As soon as rainwater touches the ground it starts to dissolve the salts which it contains. The concentration of these salts in surface water, not to mention groundwater, increases many times over. This is one of the differences between rain and artificial irrigation. Another lies in the fact that during times of rain there is high air humidity, which reduces evaporation, whereas during processes of artificial irrigation, the opposite is usually true. Salts from evaporated water stay in the ground. The outstanding Australian agriculturist, Peter Andrews, points to another aspect of soil salination which is the suppression of natural vegetation diversity, mainly through the influence of agriculture. Low vegetation, such as various grasses and weeds, are in his opinion the most efficient means of eliminating salt from the soil.[24] The systematic removal of such vegetation is one way of helping to create a salinated semi-desert.

The regulation of rivers is another chapter in the drainage of land. Adjustment of watercourses usually results in a shortening of their overall length, an increase in their gradient and a speeding up of outflow of water. Reinforcement of riverbeds and banks, removal of abandoned meanders, draining of adjacent marshes with river ecosystems, raising of weirs and flood barriers to prevent periodic flooding and other adjustments have reduced the capacity of the land to retain water.

Rapid urbanization accompanying the Industrial Revolution meant mass movements of the fast-growing global population from the country to the towns. Modern towns and cities, but also increasingly, villages too, have their surfaces reinforced with impermeable materials and have drainage systems for rainwater. A huge amount of rainwater is now drained off the paved and roofed surfaces of the "civilized world" via drainage channels running into rivers and the sea.

[22] Ruddiman W. F., Plows, Plagues & Petroleum – How Humans Took Control of Climate, Princeton University Press, 2005, s.88-94
[23] Foley J. A. et al. - Global Consequences of Land Use, SCIENCE, VOL 309, 2005, www.sciencemag.org
[24] P.Andrews – Back from the Brink – How Australia´s landscape can be saved, ABC Books, 2006, s.217-222

According to estimates, in Europe every year more than 20 billion m^3 of rainwater is channelled off, water which in the past supplied the soil and vegetation, replenished levels of groundwater, strengthened natural springs and with its evaporation, helped humidify the climate and reduce temperatures.

Deforestation, agriculture, urbanization and other anthropogenic transformations of land now affect almost 40 percent of the world's surface.[25] As we shall see, this transformation not only influences the amount of water in the land but also its climate.

The Influence of Land Use on Climate

In the preceding sections we stated that water is one of the key parameters in climate change because of its unique thermoregulatory qualities and the way its circulation is closely tied to the transformation of enormous flows of energy. Vegetation, especially natural forest, is able to manage water in a way which is unique and beneficial to mankind. We have also stated that through their activity, people contribute to the deforesting and draining of land, and thus change the balance of flows of water and energy in land. From these statements it clearly emerges that, at the very least, the use of land has an influence on the regional climate. These regional influences over enormous inhabited and human-impacted areas[26] synergically join up and also have an undoubted influence on the global climate.

Temperatures in a town on a sunny summer's day are often appreciably warmer than in the countryside nearby, while temperatures in ploughed agricultural land are higher than in forests even though the sun may be shining equally on all of these places. The main culprit for raised temperatures in urban areas is the reduced evaporation in towns resulting from a fall in green areas caused by a larger share of built-up areas and reinforced impermeable surfaces. The same goes for tilled soil, where the reduction in topsoil permeability reduces the ability of the land to evaporate water and thus raises the amount of solar energy which changes into sensible heat and longwave radiation.

This is not just a small amount of heat. Every year about 54,750 km² of the Earth's surface is urbanized and if we consider that evaporation on this kind of surface will fall by about 200 mm per year, then about 6,751,040 GWh of sensible heat are generated. If we apply the same fall in evaporation to the 127,000 km² of the earth's surface which are every year deforested, then about 17,374,000 GWh of sensible heat are generated.[27] In fact this amount alone roughly corresponds to the annual production of electricity by the whole of mankind,[28] an amount which would be even higher if we also took into account the decrease in rainfall caused by the reduced evaporation. Huge amounts of sensible heat arise in areas which were turned over to agriculture or urbanized in the past. Fields, pastures and urban zones in all continents cover an area of about 55 million km².

These so-called "hot plates" which arise in human-shaped landscape also have an influence on water circulation and climate. Higher temperatures prevent condensation of water vapour, which can then mean lower rainfall in that region. Temperature differences between hot agraro-urban landscape and wetter and cooler regions (of higher altitude or latitude) cause a higher concentration of clouds and rainfall above the latter of these.

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[25] J. A. Foley et al. - Global Consequences of Land Use, SCIENCE, VOL 309, 2005, www.sciencemag.org
[26] See e.g. works of Roger Peilke Sr. Research Group, http://climatesci.org/
[27] Schmidt M. - Global climate change: the wrong parameter, RIO 9 - World Climate & Energy Event, 17.-19.marec 2009, Rio de Janeiro, Brazil
[28] Global production of electricity in 2006 was 18 trillion kilowatt hours

Other climatic extremes and their effects which are caused by these hot plates are floods, extended heatwaves and periods of drought, forest fires, falling levels of groundwater, and reduction in soil fertility and biodiversity. Differences in the occurrence of water and vegetation leading to temperature differences provide a more direct and logical explanation for regional climatic extremes than merely the increase in the near homogeneous levels of CO_2 in the atmosphere.

There are a wealth of both old and new examples of climate change brought about by land management. Christopher Columbus wrote about how after deforestation of the Canary Islands, Madeira and the Azores, the gentle afternoon rain that was typical for these islands stopped falling.[29] The same situation occurred after the deforestation of Easter Island, the remotest island on Earth. At present there are several scientific studies drawing attention to lower rainfall in the Amazon as a result of the felling of its rainforest. This is often given as a classic example of the process.[30] Another is Florida, where its huge swamps were drained during the 20th century. The famous American climatologist Roger Pielke has documented the mechanism of the significant drop in rainfall which has now come to Florida during the hot season as well as the new phenomenon of frosts occurring in the drained areas during the cold season.[31]

It is alarming that the relevant global institutions ignore the area of climate change brought about by a change in the state of vegetation and water circulation resulting from anthropogenic land use (with the small exception of plant sequestration of carbon). Equally they almost always speak only about the effect of climate change on the water cycle and not about the reverse process, climate change as effect of changes in the water cycle.

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Encouraging the Climatic Functions of Water and Vegetation

In the previous section we stated that the drainage of a region through deforestation, agriculture and urbanisation all contribute to climatic change. If this is indeed so, then the primary measure for adapting to and assuaging this element of climate change which is caused by the drainage of land by mankind, is the renewal of water and vegetation in affected regions.

History abounds with examples of nature and climate being harmed by mankind. Positive examples are few. The ecological crisis which peaked simultaneously with the Great Depression in the 1930s in the USA is an example from the first group. This was the result of a number of decades of reckless looting of natural resources; for example, the deforestation of the country to one eighth of its original area or the ploughing up of the great prairies and their transformation into cereal monocultures, particularly during the First World War and after. Deforestation brought a change in the hydrological regime, floods, droughts and erosion. The loss of the highest quality soils from fields and pasture lands under the impact of water erosion at this time is estimated at 3 billion tons annually. Millions of acres of recently fertile land were turned into desert and the new phenomenon of gigantic dust storms began to appear.[32]

A positive example is the approach taken under the leadership of President F. D. Roosevelt, who dealt with the mentioned situation by organising the Civilian Conservation Corps (CCC) to help the unemployed and the damaged natural world. The programme, which operated from

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[29] The biography of Christopher Columbus written by his son, Ferdinand

[30] e.g.. Foley J. A. et al. - Green surprise? How terrestrial ecosystems could affect earth's climate, The Ecological Society of America, 2003, www.frontiersinecology.org

[31] Pielke R. A. Sr. et al. - A new paradigm for assessing the role of agriculture in the climate system and in climate change, Agricultural and Forest Meteorology 142, 2007

[32] Salmond J.A. - The Civilian Conservation Corps, 1933-1942: A New Deal Case Study, Chapter 1, Duke University Press, 1967

1933 to 1942, employed about 3 million young people in jobs which, among other things, included: the planting of forests; the building of fire-prevention reservoirs, ponds and dams; measures for reducing the speed and eroding force of water; the creation of retention spaces for harvesting storm water etc. As an illustration, let's just mention that the number of trees planted by the CCC is estimated to be 2-3 billion.[33] There is no doubt about the positive impacts of the programme on the lives of people and on nature. The impact of the programme on the climate can be deduced, for example, from the fact that the phenomenon of dust storms ceased.[34]

The part of the Civilian Conservation Corps programme which focused on support for the water-retaining capability of catchment areas is a great inspiration. In order for water and vegetation to fulfil their climatic function, they must first of all be present in sufficient amounts within a region. All of the fresh water on land comes from rain. Therefore it becomes a primary task to implement measures for the massive harvesting of rainwater in the places where it falls. Let drain away to the ocean only that water which we are unable to retain. The retention of rainwater is from the viewpoint of humans, ecosystems and climate more suitable than run-off, because in time and space it better preserves water between periods of abundance and shortage. Decreased run-off fulfils an anti-flood and anti-erosion functions also.

Humanity has harvested and retained atmospheric water through millennia and developed a great deal of technology for this purpose: the gathering of water from roofs, on slopes with the help of different types of depressions or terraces, into cisterns, sheets for fog harvesting, etc. While the main purpose in the past was to obtain sufficient resources for drinking water, utility water or irrigation purposes, today a climatic purpose can be added to these. That's why aside from exploitation and infiltration of rainwater the importance of its evaporation is also growing.

Evaporation, which is traditionally considered as a loss, has an immensely important climatic function for cooling a region and balancing temperature differences within it. On a healthy land the larger part of the water returns in the form of dew or rain. What is more, if there is a sufficient amount of evaporation, it "attracts rain" by cooling and by encouraging condensation of other vapours in the air. The absence of evaporation creates in a country a "hot plate" destroying the small water cycle. The recycling of water in the small water cycle is better than relying on the fluctuation of the large water cycle.

The imperative of evaporation in addition to traditional methods of harvesting rainwater opens a new spectrum of technologies which will ideally enable the saturation of soil and vegetation. It is relatively easy to find in a village such opportunities to store rainwater through the support of different ecosystems, by retaining it in wetlands and reservoirs or by saturation into the groundwater. In agriculture it is necessary, for the reasons mentioned above, to apply non-ploughing technologies and to reforest desolated and unused lands.

Rainwater, which at present drains away through sewerage systems from urban areas without being used (and for a great deal of money paid to sewerage companies) into rivers and to the sea, can be provided to lawns, parks, bioclimatic gardens, green roofs, green facades, etc. Obviously, for this purpose it would also be possible, after proper cleaning, to use the rainwater which before served only as utility water and thus relieve the drawing of valuable drinking water. Towns which consume a great deal of water should shoot for zero drainage of rainwater. It is obvious that a new water policy requires innovation in the field of land planning and architecture.

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[33] www.ccclegacy.org/

[34] http://en.wikipedia.org/wiki/Dust_Bowl

At the local and national level it is necessary to create a system of policies, legal instruments and motivations which encourage the rainwater harvesting, the protection of the small water cycle and last but not least, vegetation. Just as in the field of financial instruments the principle of the "polluter pays" applies, in the integrated management of water and land resources it is necessary to set up the principle of "he who drains – pays". Conversely, the creation of water-retention spaces needs to be rewarded financially or non-financially.

Since the climatic effects of land drainage crosses national borders, it is necessary to apply the mentioned principles both on an international and supranational level. Satellite photography in the infrared (thermal sensitive) spectrum is able to differentiate the hot parts of a country, which in the tropics and temperate zones correspond with desiccated areas or areas devoid of vegetation.[35] The international community can thus easily set priorities for its policy, and possibly monitor each advancement achieved.

The renewal and protection of the natural water cycle for climatic reasons is by no means secondary to the lowering of emissions of greenhouse gases and overtakes it in terms of the immediate urgency to ensure the fundamental needs for mankind. The international community should therefore devote adequate attention to it.

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[35] Pokorný J., Kravčík M., Kohutiar J., Kováč M. - The major role of water in the climate system of the Earth, 2009, www.ourclimate.eu

An example of the recovery plan for the Košice region of Slovakia.

A lot has been said about climate change. The scientific community perceives climate change as a consequence of human anthropogenic activity by increasing the concentration of CO2 greenhouse gases. Let's compare the graph of average temperature growth since 1960 with the growth chart of atmospheric CO2 for the same period (Figure 1). We can see they are nearly identical, and there should be no doubt about the direct correlation of CO2 on the temperature regime of the country. Therefore, most scientists working on climate change models do not doubt anything else could cause climate change.

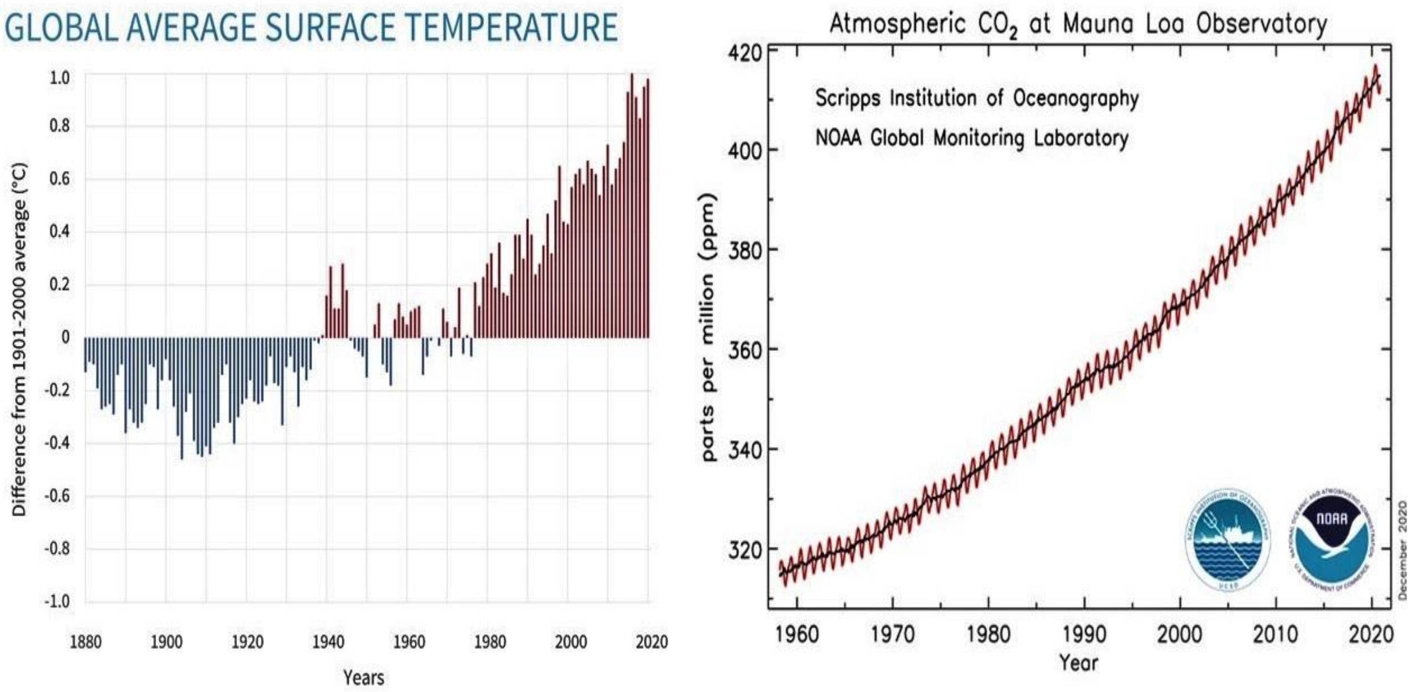

Figure 1

Are we asking the right questions?
Suppose we focus on the physical processes of the temperature regime of the planet Earth. In that case, we need to consider *all* impacts on climate change and examine water as the most abundant greenhouse gas. There are at least two laws of physics that offer a different explanation for the anthropogenic impact of humankind on climate. The law of conservation of energy and the second law of thermodynamics look beyond CO2 as the primary driver of climate change and offer answers.

Figure 2 (next page) explains how solar radiation transforms when it hits the Earth’s surface.Provided there is enough water in the ecosystems, a significant part of the Sun’s radiation is absorbed through evaporation and the ongoing transpiration of water through the vegetation during intensive photosynthesis. Up to 70-80 percent! The remaining solar radiation will contribute to soil heating (5-10%), reflection (5-10%), and warming of the troposphere (5-10%). It is worth noting that the evaporation of one cubic meter of water consumes 700 kWh of energy from the Sun. According to the law of conservation of energy, solar radiation is transformed into latent heat, which is carried by the evaporated water to the colder layers of the atmosphere. The evaporated water condenses in colder layers and forms clouds. At the dew point, rain forms, and latent energy is released into the atmosphere and warms it per the energy conservation law mentioned earlier.

Suppose we damage the existing lush ecosystems, drain and cause the landscape to dry up, or cover and seal it with impervious surfaces. In that case, we disallow the rainwater to permeate into the soil, and the natural evaporation will decline. In other words, the Sun’s energy absorption will decrease when the water evaporation decrease. In such circumstances, less water evaporates, and fewer clouds form, causing more sunlight to reach the Earth’s surface. With the decrease of natural evaporation from the degraded area, the production of sensible heat, which accumulates in the troposphere, increases, and the environment overheats and creates a thermal island (heat dome).

It’s a unique biotic pump that has been drawing the heat from the troposphere for thousands of years, like a car engine radiator. It works unless the radiator breaks down. Let me explain. What happens if the existing balanced ecosystem holding an abundance of water gets damaged and dries up? What happens when a degraded ecosystem offers no water to evaporate from the landscape? If we „dehydrate“ a balanced ecosystem, the sunlight absorption on the water vapor can drop to zero. What happens to the incoming solar energy, then? The water vapor cannot result from evaporation and plant transpiration and is absent in such a case. If solar energy is not transformed into water vapor, it is transformed into sensible heat, overheating the troposphere, and generating heat islands (heat domes).

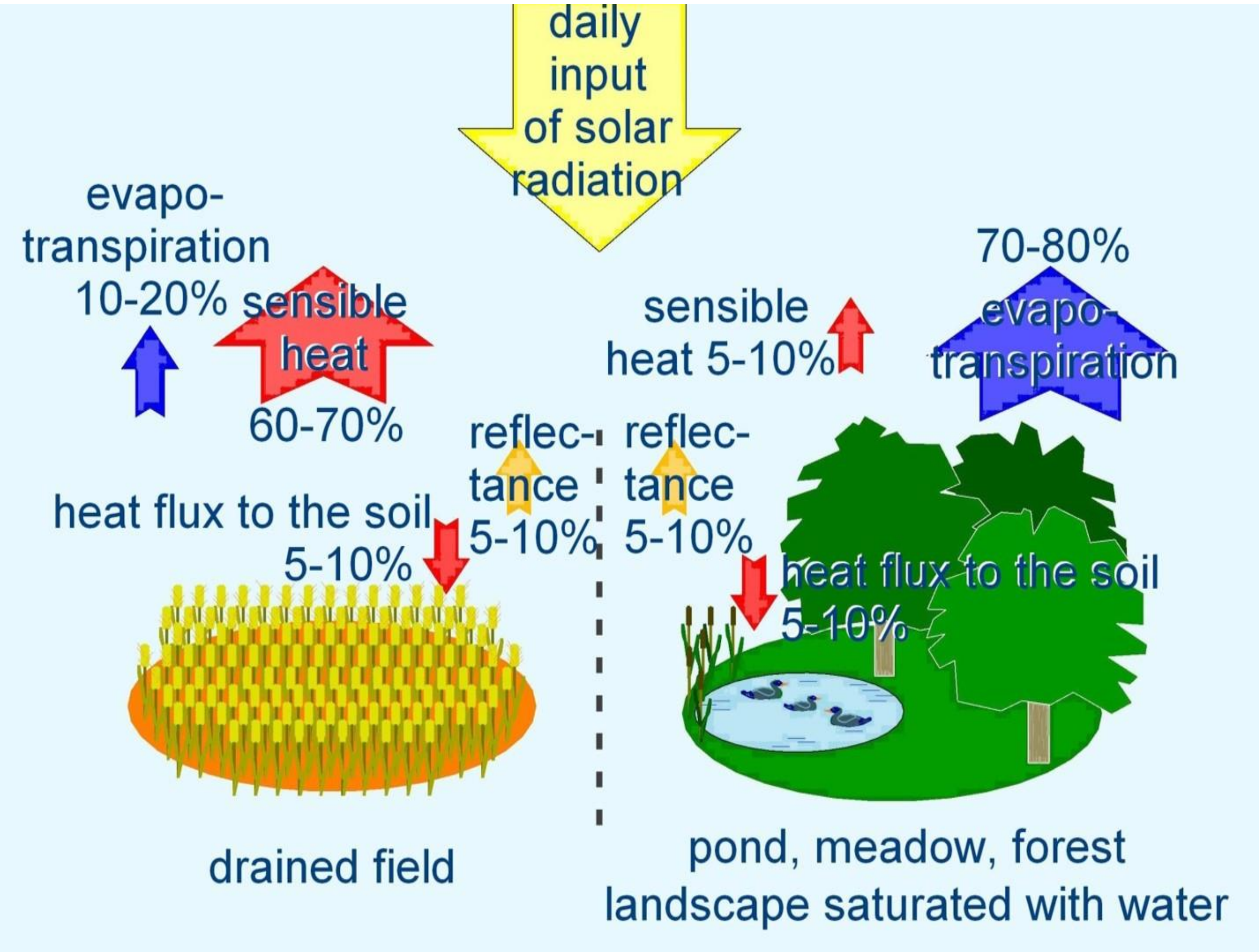

Figure 2

The left side of Figure 2 tells of a landscape in which we have made holes through and drained water from an ecosystem. (Like when a car radiator gets pierced). Therefore, less water evaporates from the Earth, less energy gets transported to the colder layers of the atmosphere, and even fewer clouds form in the sky.

As a result, more sunlight reaches the Earth's surface. It transforms into more sensible heat that accumulates in the troposphere over those arid parts of the Earth. In this way, heat islands (heat domes) are formed, overheating the landscape, especially in cities, and in poorly managed and drained agricultural land.

For a better understanding, I offer a heat distribution scheme in two environments (Figure 3). There are more clouds in the sky in an environment where there is plenty of water (left part of the picture) because more water evaporates from the ground. Through the clouds, less sunlight enters the troposphere. At the same time, less sensible heat and more latent heat are produced from the incoming sunlight on the Earth's surface as more water evaporates from the soil.

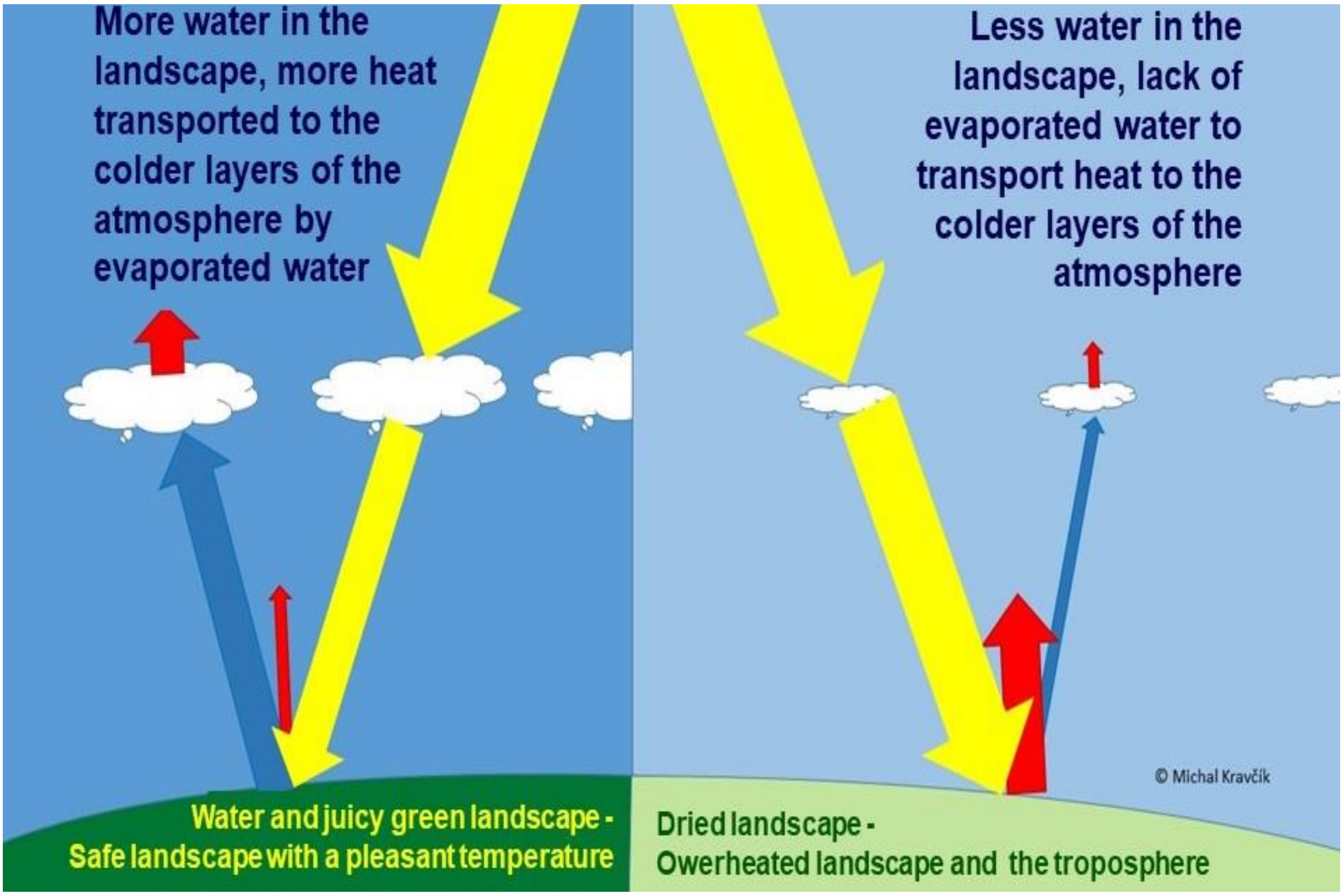

Figure 3

The right side of the picture talks about dry land. Less water evaporates from the ground, less energy is transported to the colder layers of the atmosphere, and even fewer clouds form in the sky. As a result, more sunlight reaches the Earth's surface. It transforms into more sensible heat that accumulates in the troposphere over those drier parts of the Earth.

During the condensation of evaporated water vapor in the atmosphere, clouds form, which reduces the permeability of solar energy through the clouds and alleviates the overheating of the atmosphere below them.

The solar radiation that does not get reflected but penetrates the clouds is absorbed by the vapor (blue arrow) when it hits the Earth's surface. The solar energy that is not consumed by the vapor is converted into heat (red arrow) and heats the above-ground atmosphere (troposphere).

In a landscape with enough water, solar energy transformation by the vapor is dominant (blue arrow), as liquid water molecules are available to consume the incoming solar radiation and change the state from liquid to gas. In a landscape where soil moisture is low, the unabsorbed heat transforms into sensible heat. It overheats the ground layers of the atmosphere (red arrow).

According to the second law of thermodynamics, the converted solar energy is transported by the evaporated water to the colder layers of the atmosphere and heats them. This reduces the temperature gradient between the ground and upper layers of the atmosphere, preventing the growth of weather extremes.

Let's look at a city like Budapest, Hungary. Before the people of Budapest developed its land with buildings and roads, the rainwater would evaporate, and saturate the ground, supplying the vegetation and groundwater aquifers. These days, at least 100 million m3 of rainwater collects annually in the regulated drainage infrastructure and empties to the Danube River. In the past, this water would evaporate into the colder layers of the atmosphere. Instead, more than 70 TWh of sensible heat per year is now released from this territory into the troposphere. Therefore, summer temperatures have been 3-5 degrees Celsius lower in the past. Interestingly enough, the Hungarian economy utilizes 70 TWh in 1.5 years (Hungary's total energy consumption in 2018 reached almost 46 TWh – to be verified).

On this principle, we have developed a Green Restoration Plan for the Košice Region of Slovakia, which was approved by the Košice Regional Parliament on 19 February 2021. It is an integrated landscape and watershed program that will benefit several, providing a roadmap for ecosystem restoration. The Plan's implementation will increase the water retention capacity of the damaged landscape of the Košice Region by 60 million cubic meters with a total cost of 400 million €.

This Plan will contribute to creating:-

- ✓ 3 200 jobs
- ✓ An annual sequestration of 6.6 million tons of CO_2 to vegetation and soil,
- ✓ A yearly increase in the fertility of the agricultural landscape by €30 million,
- ✓ The restoration of dried water springs of 12,000 litres per second,
- ✓ An increase in latent heat production and the return of more regular rainfall,
- ✓ The formation of horizontal precipitation (dew),
- ✓ A decrease in the production of sensitive heat and the mitigation of atmospheric disturbances
- ✓ A subsequent reduction in the incidence of weather extremes and flood risks,
- ✓ An average temperature drop of 0.77 degrees Celsius.

The projected return on investment in this program is well below ten years. Such a model can be implemented in all parts of the world, increasing climate, environmental, water, and social security.