Water, Land and Climate --The Critical Connection

How We Can Rehydrate Landscapes Locally To Renew Climates Globally

Water plays a critical role in restoring a livable climate.
A New Water Paradigm is emerging to help us restore landscapes naturally, so we no longer wastefully "drain the rain" but instead "retain the rain" with water catchments, soil, plants and animals.
The result?
We can renew our climates through local action, by allowing rainwater to soak into the soil to restore local land-based water cycles. We can also expect reduced flooding and pollution, renewed springs and streams, more drinking water, more food, less poverty and conflict, and improved wildlife habitat.
There is nothing to lose and everything to gain!

Jan Lambert

With contributors from around the world

The Valley Green Journal
Grassroots connections – agriculture, communities, nature
SPECIAL BOOK EDITION

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How We Can Rehydrate Landscapes Locally To Renew Climates Globally

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Jozef Matúš photo

Constructing a check dam in Slovakia for rehydration of a forest landscape.

Special Edition of the
Valley Green Journal
Lone Leaf Graphic Design
Putney VT

The Valley Green Journal

Grassroots connections – agriculture, communities, nature

Special Book Edition

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Carmen Bywater photo

Keepin' track of the rain.

Lone Leaf Graphic Design

Putney VT, USA

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Photo by Carmen Bywater

Droplets collect on a tall plume poppy after it rained.

FOREWORD

Reconnecting With Water: A Dedication to Beavers

By Jan Lambert

Water is the driver of Nature.
- Leonardo da Vinci

Think about how our own bodies, which are mostly water, operate according to the laws of hydrology, the branch of science concerned with the properties of the earth's water, especially its movement through cycles. Water we drink flows through our veins and other bodily systems. When we get too warm, glands produce sweat, which cools us down via the power of evaporation. We cannot survive very long without water. If we are dehydrated or we get too hot, we can be in serious trouble. Chronic dehydration is much more common although often unrecognized, and takes its toll on the overall health of many people.

The need of a constant supply of water for the human body—water flowing, evaporating, and condensing in cycles—is also the need of the landscapes that we call home, our particular portion of Planet Earth. Nature knows how to cycle and re-cycle water in a most efficient and elegant manner, not only in our own bodies, but in and through our landscapes and our local atmospheres, whether urban areas or countryside. If we interrupt those cycles and prevent rains from soaking into the land, our landscapes become dehydrated with unhealthy consequences. This is happening all over the globe, resulting in floods and droughts and contributing significantly to climate change.

Water cycles are central to nature's design, and nature should be our ultimate guide to how we manage our landscapes for our own wellbeing as well as the ecology of the planet. The living soil, the forests and other plants, and animals, and the atmosphere all interact with water, which is arguably the most amazing substance on this planet. As it moves from liquid to vapor to solid and back again, water performs many feats to keep the planet alive. We need to understand, that it is essential that water be allowed to cycle in the ways nature has provided, in order to revive our ailing planet.

With nature's wisdom in mind, I dedicate this book to beavers, those amazing creatures who, I am happy to say, are now common again in my region, the Northeast of the United States. Unfortunately beavers tend to get in the news and the general mindset, only because sometimes their dams flood roads and property. But it is important to understand that these animals are vital to the health of our landscapes, our water supplies, and our climates. Nowadays we realize why beavers are so important, after noting what happened after beavers were almost trapped out of existence by the 19th century here in the United States. The water tables dropped, floods and droughts increased, entire floodplains changed shape, and wildlife died out. This was all because the natural landscape was dependent on the water management of beavers.

Lisa Tennyson photo
Wachusett Meadow, MA (USA).

Beavers build numerous small dams that hold water back, creating ponds and wetlands that are rich in biodiversity. Rainwater is collected and soaks into the ground, keeping the water table stocked with moisture that will tide the land over during a dry spell. Beavers stay in an area until their supply of wood has run out. While residing in an area they build multiple canals to help them

move more wood to their dam and lodges. This disperses water throughout the area and creates extensive wetlands. Rich wetland vegetation draws carbon dioxide from the air, capturing carbon into the ground which in turn holds more moisture and increases fertility. When the beavers finally move on, and their dams break down, what is left is a rich wet meadow which in turns supports a whole new diversity of plants and wildlife. The moisture is still there, being transpired by the vegetation and cycling back into the atmosphere to form clouds and more rain over the region. And so the cycle goes around again and again, and the beavers are a major player in retaining precipitation in the landscape that starts the cycle anew.

Glynnis Hood, a wildlife biologist from Canada, has written a book, *The Beaver Manifesto*, in which she concludes, "There is something in that persistent drive to sustain water on the landscape that is a clue for our own survival as a species. Whether we take the time to learn from other species depends on our own adaptability and willingness to see our world and the resources within us in a new light."

As you will see in this book, much great work is being done to retain rainwater in the land of forests, farms and cities. Various "green" methods allow water to cycle through soil and plants, and back into the atmosphere, instead of just draining directly into rivers.

In many cases the dam-building techniques of beavers are being copied by humans, so in a way we are becoming partners with beavers. May we all get a little better acquainted with these furry water experts and let them guide us in land and water restoration!

Courtesy photo

Beaver dams are very beneficial for slowing down and retaining rainwater.

Michal Kravčík photo

This small dam in Slovakia was constructed by humans but inspired by beavers.

INTRODUCTION

Water Cycles: In Concert With Nature

We forget that the water cycle and the life cycle are one.
- Jacques Cousteau

As the editor of an environmental newsletter, I am excited to be sharing a renewed understanding of the natural cycles of rainwater and the land. It's a worldwide revolution that is blending ancient wisdom with modern science, to transform both cities and rural areas into new green and thriving spaces. We are starting to restore our regional climates by following nature's ways of cycling water, and we all can learn and be inspired by success stories across the globe. I believe nothing is more important to the wellbeing of earth and humanity than this knowledge: by allowing rainwater and melted snow to move in its natural cycle in the land, and the atmosphere immediately above our regions, we can solve a large number of environmental and human needs simultaneously. The basic action needed is simple—soak up rain and snowmelt in the land— the methods are many, and the results profound.

In nature water, plants, and soils all function together harmoniously with the atmosphere to absorb and regulate the flow of precipitation.

Jan Lambert photo
Forested areas are ideal for cycling rain water, NH (USA).

Jan Lambert photo
The forest floor functions as a "sponge" to absorb and hold moisture until it is transpired back into the atmosphere by plants, creating a cooling vapor that condenses into clouds.

Natural landscapes provide a "giant sponge" with ample vegetation and deep root systems and soil life that absorb water easily, replenish groundwater, and release a cooling cloud-forming water vapor, via plant transpiration, into the atmosphere to later fall as rain. This is the essence of the regional, or small water cycle.

For centuries humankind has greatly interfered with local water cycles by way of poor agricultural methods and deforestation that bare the soil. More recently has come massive urban and road development, where rain is often treated as a waste product termed "stormwater." Urban areas and roads not only prevent stormwater from entering the ground with pavement and rooftops, but also drain the runoff directly into rivers, lakes, and oceans with downspouts, storm drains, and pipes. Stormwater runoff is a major source of water pollution as well as contributing to flooding,

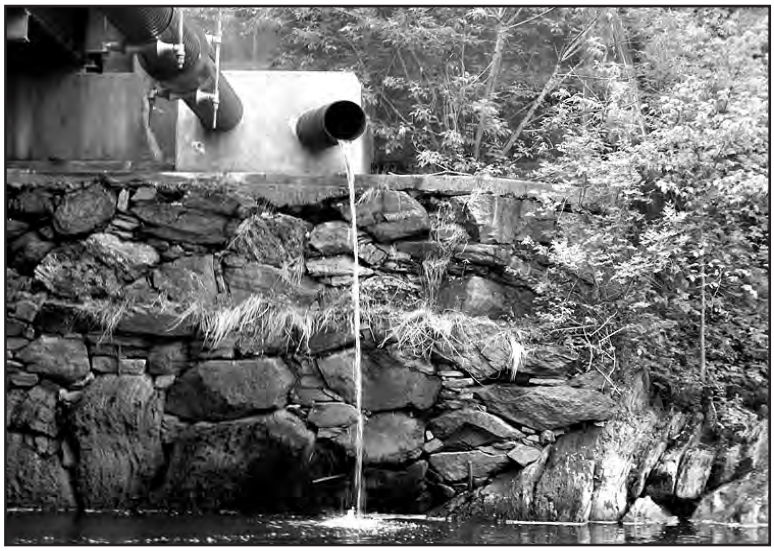
drought, and diminished fresh water supplies. Furthermore, less water into the land leads to less plant growth, the plants so greatly needed as prime regulators of climate.

Human intervention is needed quickly, to "jumpstart" the process of restoration in seriously degraded or paved-over landscapes. A critically important yet simple way for humanity to work with nature is being demonstrated around the globe by farmers, urban planners, foresters, and homeowners rediscovering the many benefits of allowing the rain and snow that falls on the land, to soak in where it falls. We all need water to survive and thrive, of course, so there is good reason for everyone on earth to be motivated in helping to direct the flow of precipitation into the land. By doing so we can curb erosion, pollution, floods, and droughts, replenish water tables, increase farm and ranch yields, increase property values, and create beautiful green areas for recreation and wildlife, all the while helping to moderate local climate.

Every one of us needs to be involved in welcoming precipitation, coaxing our local precipitation into the land by creating " earth sponges" in concert with nature. Grassroots, local community action is needed. If enough citizens take simple actions, we can transform our barren, infertile, eroded and paved-over areas into delightfully luxuriant, vegetation-rich healthy pieces of landscape. Community actions add up to global action.

Michal Kravčík photo

Paved surfaces in urban areas channel water directly into streams, instead of soaking into the land as nature intended.



Jan Lambert photo

The world is full of success stories of landscapes and waterscapes brought back to life through simple water-retaining practices. Whether in a tiny village in India or a large metropolis in America, the concept is the same: save the rain in the land on which it falls and the rewards will be great. Saving water takes many forms, depending on whether the setting is on a farm or ranch, in a tiny village or a huge city, in a forest, or at the roadside.

Furthermore, the connection between stormwater management and climate change is being addressed much more in recent years, as climate action moves toward communities preparing to be more resilient to unpredictable changes such as more severe storms. A growing number of researchers and land managers are discovering that poor water management practices were likely the major cause of a great deal of our undesired climate changes, changes which are often blamed solely on the buildup of greenhouse gases.

A primary goal of this book, therefore, is to bring to light in-

sights from scientists, researchers, and land restorers who are pointing the way toward a more balanced view of how to address climate change that includes regional, or small water cycles. And it is undeniably good news that needs to be known to give humanity fresh hope: by using a variety of existing and emerging measures for capturing precipitation in the land, there is much that we can do to restore local water cycles within our landscapes, which could significantly moderate our regional climates, and greatly increase productivity and biodiversity.

This book is based in particular around the work of a group of Eastern European researchers who have developed an intriguing examination of how humanity's attitude toward precipitation has gone counter to nature, with the coming of an industrial approach to water management, and how we can alter our approaches to better serve the needs of ecosystems and humanity. Their comprehensive yet very readable book is titled *Water For the Recovery of the Climate-A New Water Paradigm*, edited by one of the authors, Michal Kravčík, a hydrologist in the nation of Slovakia. I give Vermont author Judy Schwartz credit for introducing me to their work, which she calls "stunning," in her book published in 2013, *Cows Save the Planet: And Other Ways of Restoring Soil To Heal the Earth*.

Canadian Maude Barlow is a global activist and prolific author concerning the ecological, social, and political effects of water management. In her latest book *Blue Future*, Maude presents the global struggle for water rights, exposing how water is being made into a commodity by the rich and used to control the poor. She portrays Michal Kravčík as a pioneer in helping to provide a water-secure future for all peoples. In an email she told me, "Michal Kravčík is not only a leader but a prophet. He has done more to make the world aware of the role that our abuse of watersheds is a major cause of climate chaos than anyone I know, and we owe him a great debt of gratitude."

Michal Kravčík photo

BLUE ALTERNATIVE (Slovakia) Restoring eroded landscapes with water catchments transforms barren land to vegetated "forest sponges."

I introduced myself as a journalist on the Facebook page, Blue Alternative, to Michal Kravčík in the fall of 2014. Within months we had developed a working partnership, with Michal emailing me his writings so that I could polish them up for English translation. This has led to us co-authoring a paper on worldwide landscape water restoration, "A Global Action Plan For the Restoration of Natural Water Cycles and Climate," which is published for the first time in this book.

My intent is not to satisfy readers but to awaken a desire to know more. The articles are all linked together like a web, with the common thread of water cycle restoration. This book is not intended as an instruction manual, although there are practical resources listed. It is instead intended as an inspiration for networking and action. Each article introduces a particular perspective on landscapes and water, with resources at the end of each article for more information. Finally, I would like to make it clear that important findings are summarized here. I do my best but I may not capture the message entirely. Therefore I encourage readers to seek out more. Consider all of us as members of a network, a web of ideas and stories of happenings.

If you wish to learn firsthand the contents of *Water For the Recovery of the Climate: A New Water Paradigm* (NWP), you can search for the title now on the internet, and download your own free 94 page copy. Or you can explore the pages here, and find articles by several writers about the NWP in Section One, and stories of action and inspiration in Section Two. I would love to get your feedback and will try my best to answer every email. You can contact me at jan@valleygreenjournal.com. Thanks so much for your interest!

Jan Lambert
September 2015

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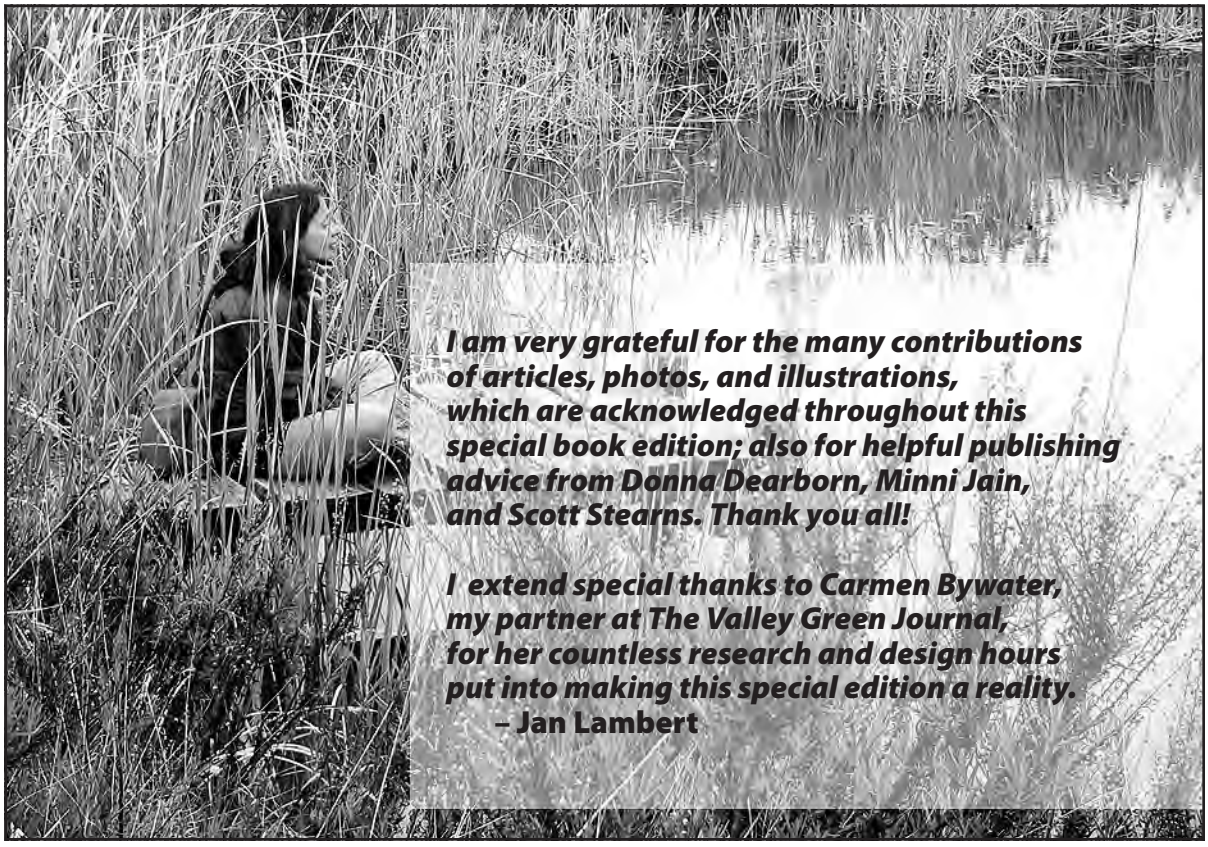
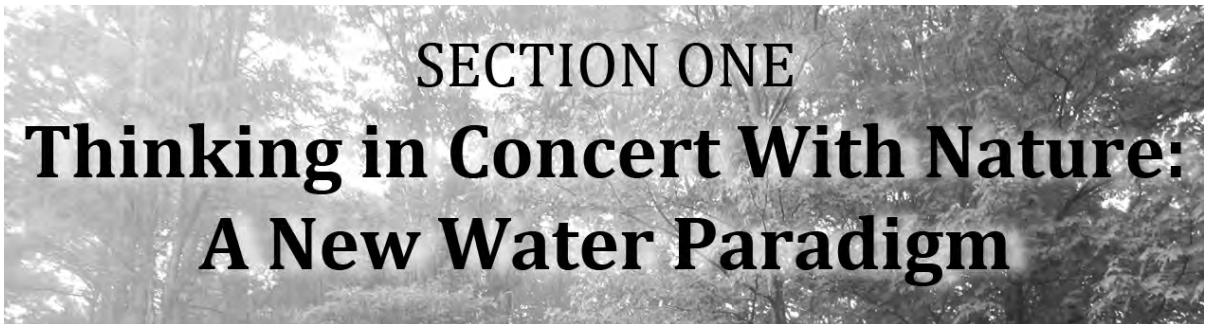


Michal Kravčík photo



SECTION ONE

Thinking in Concert With Nature: A New Water Paradigm

Cool It! Water and the Climate Crisis

By Judith Schwartz

Judith Schwartz is the author of Water In Plain Sight: Hope for a Thirsty World, *due for release July 2016 -- St. Martin's Press.*

With a record drought in California, floods in the UK and snow paralyzing areas of the South that have hardly met a plow, people are starting to make the connection between climate change and water. But generally the cause-and-effect link only goes one way, noting how climate change will affect water by putting stress on global water sources while parts of the world get soaked. This is a real concern. But we're not seeing the other part of the picture: the effect that water can have on climate. You see, water in its various forms is an important thermoregulator of climate. By working with the water cycle—most basically by keeping water on the land in soil and vegetation—we can address climate changes locally, regionally and even beyond.

There's a group of Eastern European scientists who have written a book called *The New Water Paradigm: Water for the Recovery of the Climate*. I have to say, it fairly blew my mind. Co-author Jan Pokorný, a Czech scientist, explains how evapotranspiration, the upward movement of water through plants, is the "most powerful vehicle for solar energy transformation" in existence. Living plants transpire, which is a cooling mechanism. When soil is covered up, paved over, or dried out, there's no transpiration and the ground heats up – as is happening more and more in the middle of the country, our once vaunted "breadbasket" – as well as around the world. If we focus on keeping soil moist and covered with plants, we can build microclimates of cooling. Microclimates can eventually add up to macroclimates, and this shifts multiple dynamics that affect climate.

It's useful to consider that water vapor is the predominant greenhouse gas in the atmosphere, not carbon dioxide. Water vapor makes up between 1 and 4 percent of the atmosphere, whereas carbon dioxide is 0.0397 percent (that's the parts-per-million figure we hear about.) Water has a greater capacity to absorb thermal energy than any other known substance. At the same time, it's in constant flux, moving through the atmosphere and between forms, shape-shifting from gas to liquid to solid and back again. For this reason water vapor is hard to measure and plug into climate models.

We don't have to wait for carbon dioxide levels to come down in order to mitigate climate change – we can begin to restore the water cycle, which will in turn restore ecosystems. Moreover, we need to do this. For here's what we don't talk about when we talk about climate change: we can draw all the carbon out of the atmosphere that we want and still have the problems we now associate with CO2-driven climate change. As Walter Jehne, a soil microbiologist and Director of Healthy Soils Australia puts it: Water is not a secondary feedback; it can be used as a primary vehicle of climate relief.

Water for the Recovery of the Climate – A New Water Paradigm, is available at http://www.vodnaparadigma.sk/indexen.php?web=./home/homeen.html.

Michal Kravcik, one of the authors of the New Water Paradigm, blogs on the California water crisis: http://www.goldmanprize.org/blog/michal-kravcik-reflects-california%E2%80%99s-water-crisis

Rehydrating the Earth: A New Paradigm For Water Management

By Richard Widows

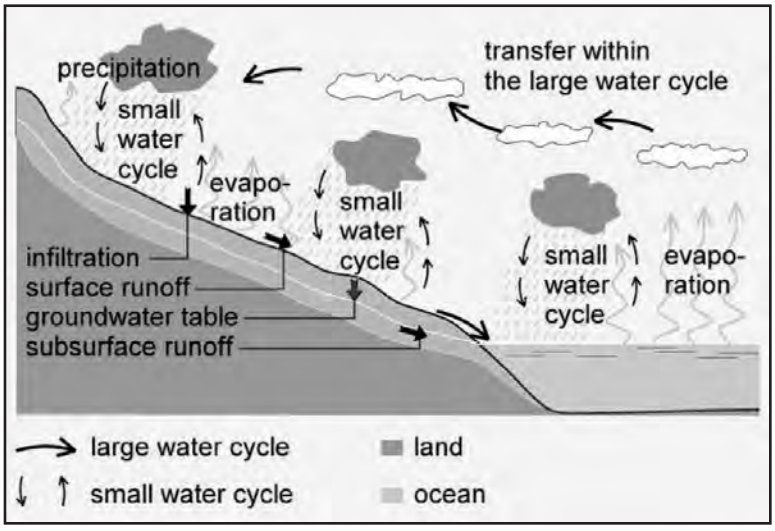
Richard Widows is an agricultural scientist with ten years professional experience in the agricultural sector, with a particular focus in agricultural policy. He has recently completed a Masters in Holistic Science at Schumacher College in the UK. Richard is currently working as an independent digital strategy consultant whilst exploring agroecological food stories in the UK and Europe. He also works with the UK based Water NGO, the Flow Partnership and runs his own website www.ourfoodfuture.com.

"The wars of the 21st century will be wars fought over water." These are the now famous words of former UN Secretary General Boutros Boutros-Ghali, words that a growing number of authors are repeating today. But what if, instead of providing the catalyst for war, water could instead be the catalyst for deep, holistic and sustainable human participation in earth systems?

As someone drawn to holistic science and the need for change towards big picture thinking, I struggle to think of a single area more ripe for holistic engagement than water management. I say this because, whilst my intention here is to articulate a complete paradigm shift in the way in which we think about and approach water management in our basins and catchments, none of the arguments I will be using to support this position are particularly controversial. What is unique here is approaching the subject in a holistic manner.

The development and adoption of a new holistic water management paradigm, a paradigm that acknowledges, seeks to understand, and in some instances to reverse, humanity's impact on the "small water cycle," could be one of the most important challenges we face. The good news is that at its most fundamental level, the change in approach can be summarised in one short sentence: a shift from the current paradigm reality, where evaporation is viewed as a loss to the system to be avoided at all costs, to a new paradigm, where evaporation is understood and respected as the source of all precipitation and managed accordingly.

To understand the importance of this statement, we must first understand that there are two major parts to the water cycle, the "large water cycle" and the "small water cycle." As can be seen in Figure 1, both large and small water cycles govern precipitation on land and sea. The large water cycle, however, which is the exchange of water between ocean and land, causes 74% of precipitation over the ocean, while just 26% of the precipitation from the large water cycle falls on land (Kravcik et al.,2007, p. 16).



The small water cycle can be described as the closed circulation of water in which water evaporated on land (or water) falls in the form of precipitation

over this same environment. Don't be misled by the name; the "small" water cycle, as it is actually more important than the large water cycle to local precipitation patterns. It is estimated that mean global precipitation over land is 720 mm, of which only 310 mm is from the large water cycle and 410 mm comes from the repeated evaporation-precipitation process of the small water cycle (Kravčík et al., 2007, p. 17). In other words, up to two thirds of precipitation on land actually comes from the small water cycle. Acknowledgement of this simple reality alone should be enough to completely transform our approach to global water management. There is nothing controversial about the existence of the local or small water cycle, it is simply a term that does not get used in current paradigm water management discussions. Furthermore, it is the small water cycle that is interrupted by human activity, and it is therefore the small water cycle that we can seek to act upon by becoming conscious of our influence upon it.

However, before I get into more detail about the small water cycle and how we might influence it, I want to explore the current paradigm approach to water management, via the example of a globally relevant Australian water management planning process that I was closely involved with, the Murray Darling Basin Plan.

The Murray Darling Basin is one of the largest and also driest river systems in the world. Running from central Queensland, through New South Wales and Victoria, and eventually, down into South Australia where it meets the sea near Adelaide, the Murray Darling Basin covers an area of 1 059 000 square kilometres, around 14% of the Australian continent (MDBA, 2014a).

Entire books have been written on the political complexity of the Murray Darling Basin, but to get an idea of its significance, it is important to understand that the basin contains approximately 40% of Australian farms and around 70% of Australia's irrigated land (MDBA, 2014b). In addition to this, the Murray Darling Basin is also the primary water source for a number of significant towns and cities.

Essentially, the Murray Darling Basin Plan was a multi-billion dollar Federal Government initiative designed to redistribute a perceived over-allocation of water resources, in the hope of revitalising the basin environment. This process was initiated following a decade of the worst drought on record, and in the light of scientific predictions of increasing weather variability resulting from climate change.

The Murray Darling Basin planning process involved four separate state governments and countless stakeholders all seeking individual outcomes. At the broadest level the Basin Plan operated on the premise that allocating more water to environmental sites was the best we could do to "fix" the perceived environmental problems in the Basin.

However, whilst certainly effective in reallocating water to the environment, the Basin plan never got to the deeper level questions of water management, such as: is human activity playing a role in increasing climate variability? And if so, what can we do to begin reversing these trends? In over four years of being involved with the Murray Darling Basin Planning process, I heard almost no discussion about the water cycle and how human activity might be influencing it, yet this is where I believe our approach to water management needs to change.

Luckily, in Australia we do not have to look very far for examples of pioneering water management practitioners who have adopted a far more holistic approach to water management. P.A. Yeomans, for example, released his first book, The Keyline Plan in 1954. The Keyline approach seeks to remould the landscape using specialised methods of planning and design based on water control and land management. The primary aim of this approach is to increase the depth, stability and fertility of soils (Yeomans, 1954). Over the past three to four decades, Keyline practices have become a significant addition to the Australian rural landscape, forming, among other things, a key platform upon which the permaculture design process is based.

More recently, another Australian farming pioneer, Peter Andrews, has come up with his own philosophy on landscape rehydration and ecosystem restoration, "Natural Sequence Farming." Like Yeomans, Andrews places his major focus on the restoration of degraded soils. Based

on the knowledge that soils have the capacity to hold twice as much carbon as the atmosphere, Natural Sequence Farming is designed to restore ecosystem functions by "re-coupling the carbon and water cycles" (Norris & Andrews, 2010). This approach is unique in its attempts to create managed systems designed to mimic natures own design, and has achieved significant success in its short history in Australia.

Being Australian and having worked in Australian water policy I am more in touch with Australian examples, but that is not to say that there are not also interesting global case studies as well. India's Rajendra Singh and Zimbabwe's Allan Savory are two leaders that come instantly to mind.

Often referred to as the "waterman of India," in 1984 Rajendra was working to set up health clinics in the state of Rajastan when he was told that they needed neither medicines nor food, but water. This simple statement led Rajendra on a journey of learning and action that resulted in him being named as one of the 50 people who could save the planet (Guardian, 2008). Rajendra's work is particularly interesting not only for its focus on traditional methods of water conservation and unique approaches to community engagement, but also for its irrefutable and broadscale success. By working with the local community to build over 8 600 strategically placed small dams or johads, Rajendra has been able to help bring water back to over 1 000 villages and restore the water flow of five major Rajastan rivers (Guardian, 2008).

Richard Widows photo

Hydrologist Michal Kravcik, and Minni Jain of The Flow Partnership, http://www.theflowpartnership.org/#introduction, in the UK, tour the Water Forest project in Slovakia, where degraded clearcuts were restored into healthy young forests with the aid of rainwater retention catchments.

Allan Savory is a Zimbabwean born biologist and farmer behind the concept of Holistic Resource Management. Savory's area of focus lies in what he terms "brittle environments" (up to a third of the worlds lands), which he defines as "areas where there are prolonged periods of the year in which conditions for plant growth are adverse" (Savory, 1983). Over the past few decades, Holistic Resource Management has achieved significant success by using livestock to mimic the herds of native wildlife that once roamed the worlds grasslands. This method is particularly interesting for its unique approach to addressing desertification in a significant proportion of the worlds lands.

This list is by no means exhaustive, these are simply four prominent examples of pioneering individuals who have taken a more holistic view of the role of water in our environments. And, importantly, they have been achieving remarkable results over varying periods of time. The sort of results that prove that we can reverse trends of global desertification and begin to rehydrate our landscapes. Results that, in my view, provide significant hope for the future of humanity.

Interestingly, the more I look at these, and similar approaches, the more I feel they are all intrinsically connected. Essentially, whilst they may use different techniques and means, they are all rooted in a holistic understanding of the key role of water in our ecosystems and environments. What appears to be missing is a language to bring these pioneering approaches together, a language that can explain why these approaches have achieved real, demonstrable results, whilst not requiring us to align ourselves completely with any one specific philosophy or

individual. Enter Slovakian hydrologist Dr Michal Kravčík and his colleagues, and their call for a "new paradigm in water management."

I first came across Dr Kravčík via a book he co-wrote in 2007 called – 'Water for the Recovery of Climate – A New Water Paradigm'. At this time I had been working in the water policy space for four years, and this was, remarkably, the first time I had ever heard anyone mention the small water cycle. Kravčík was the recipient of the 1999 Goldman Environmental Prize for his work in galvanizing support to halt a proposed mega-dam project that had been planned during the communist era. He achieved this by proposing a series of effective, democratic and cost effective alternatives, including smaller dams, decentralized water management, and restored farmlands (GEP, 2 000). But possibly just as importantly, in articulating what I will refer to as the New Water Paradigm(NWP), Kravčík and his colleagues have provided something that may have much broader impacts on water management – a new language to unite holistic water management practices from around the world.

A fascinating aspect of the NWP is that it "is not founded on new, revolutionary knowledge; its newness arises more from thinking through existing knowledge to its logical consequences" (Kravčík et al., 2007 pg. 7). The most important concept to understand about the NWP is that its proponents believe that the leaching of fresh water from land into the oceans is one of the most significant factors not only in global desertification, but also in climate change. Essentially, the NWP explains how human activities, such as deforestation, agriculture and urbanisation, have gradually reduced soil moisture, ground water, and vegetation, which in turn have reduced on-land evaporation, completely interrupting the small water cycle.

If there is anything revolutionary about the NWP, it lies in its focus on the small water cycle. The NWP is, essentially, a "plan for saturating the small water cycle through the conservation of rainwater on land" (Kravčík et al., 2007 pg. 7). Rather than focusing on dams and rivers, the NWP focuses instead on slowing down the progress of water through the system, holding it in soils, vegetation and groundwater systems, based on the knowledge that the small water cycle will ensure the water is continually cycled through the landscape before eventually returning to the ocean. In simple terms, the new paradigm for water focuses on getting the most possible value from water on land via the small water cycle.

As it is the small water cycle that is interrupted by human activity, its absence from policy discussions highlights the disconnect inherent within current paradigm approaches to water management. The best example I can think of to highlight this point involves a debate often referred to in Australia as the "war of the willows." This debate revolves around a premise that willows are particularly thirsty trees, and, as they are an introduced "weed" species, removing willows could save up to 5.5 megalitres of water per year, per hectare of canopy area (Doody & Benyon, 2011).

This is an argument being put forward by the Commonwealth Science and Industrial Research Organisation, and is therefore highly representative of Australia's current paradigm approach to water management. The problem is that the argument in favour of removing willows completely ignores the water once it has been "used" by the willows: it completely ignores the small water cycle. This is the point; almost all policy relating to water management ignores the small water cycle.

Once water has evaporated it is gone as far as our current paradigm thinking is concerned; water is viewed primarily in rivers and dams, and less so in ground water, as "real" water. Almost all water policy is geared around the regulation of these forms of water, and this is understandable given that water has become a highly valuable commodity. The problem is that this approach to water management has led us to forget about the other areas that water is held in our environments, such as soil, vegetation and the atmosphere; or worse still, as in the example of the willows, to actively discriminate against water in these forms.

When we think in terms of the NWP, we understand that all vegetation, instead of being a "user" of water, is instead a key regulator of water in the environment. Indeed, we begin to

think in terms of the role that plants are playing in the circulation of water and in the transformation of solar energy, that is as temperature regulators.

One of the key premises of the authors of the NWP is that the roles that water and vegetation play in concepts such as the greenhouse effect and global climate change have thus far been greatly neglected (Kravčík et al., 2007 pg. 23). The primary reasons provided for this neglect relate to the fact that the circulation of water is extremely dynamic and complex, often involving innumerable mutually connected processes. Instead of being treated as an important greenhouse gas, water is instead treated as somewhat of a climatic constant and therefore not included in many climate models. However, this approach dramatically underestimates the importance of water in the climate (Kravčík et al., 2007 pg. 29).

The role of water in our climate may be under-researched, but what is certain is that a key condition for the alleviation of climate change is the renewal of basic ecological functions that are closely associated with increases in water and vegetation on land. These functions primarily include the "soft dissipation of solar energy through the cycling of water" and the increased absorption of carbon dioxide and conservation of nutrients on land associated with increased vegetation (Kravčík et al., 2007 pg. 29).

By beginning to become conscious of how human activities have contributed to the leaching of water from land and into the oceans, we can begin to employ policies and practices that seek to reverse these trends. By acting to increase the amount of fresh water on land, we increase the diversity and resilience of our ecosystems. In turn we will begin increasing the organic content of our soils and landscapes, pulling in large volumes of carbon from the atmosphere.

There are numerous global examples of tried and tested NWP-aligned philosophies and practitioners. Our work now involves drawing these examples together and looking at them through the lens of the NWP, to develop a common language for articulating how these results are being achieved and why.

The choice is simple. We can continue to ignore the role of humanity in the dehydration of small water cycles across the globe, and attempt to apply increasingly large band-aid solutions, as I experienced in the Murray Darling Basin Planning Process. Or, we can pick up the initiative that has been offered to us by the many pioneering NWP thinkers, and make genuine attempts to create a sustainable future.

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The Human Right to Water

By Maude Barlow

Maude Barlow is the National Chairperson of the Council of Canadians and chairs the board of Food and Water Watch. She is the recipient of twelve honorary doctorates as well as many awards. In 2008-2009, she served as Senior Advisor on Water to the 63rd President of the United Nations General Assembly and was a leader in the campaign to have water recognized as a human right by the UN. She is also the author of dozens of reports, as well as 17 books, including her latest, Blue Future: Protecting Water For People And The Planet Forever.

One of the greatest challenges faced by water restoration projects such as presented in this book, is to incorporate the human right to water with ecosystem concerns. This is because the struggle to bring safe drinking water and sanitation services to all is confounded by the growing scarcity of water in many parts of the world. The ecological crisis will deepen the human rights divide unless we actively work to avoid such a scenario.

It is crucial that those fighting for water justice and those working to protect water and watersheds come together in a powerful new movement. Environmentalists must realize that they cannot protect a river if thousands of people with no choice have to use it as an open sewer every day. Similarly, human rights advocates need to understand that a world running out of clean water will exacerbate the human crisis and that they too, need to protect watersheds from over-extraction and pollution.

One of the clear instructions to governments from the United Nations Human Rights Council is to place the vulnerable at the heart of any plan to deal with the water crisis. This means special attention must be paid to women, rural communities, peasants and small farmers, and indigenous peoples, who are frequent victims of water theft, water contamination, exploitation of resources on their territory and forced displacement. And no longer is this crisis found only in poor countries of the global South. Water cut-offs to the poor have spread to the global North. In American cities, such as Detroit and Baltimore, water rates have soared and many thousands of people unable to pay their water bills have had their water shut off. The same is happening in cities in Greece, Italy and Spain in the wake of austerity-imposed rates hikes. Suddenly the global water crisis is truly global.

As governments start to be hit by droughts and water shortages, they are beginning to announce plans to deal with the growing demand for a dwindling resource. Many communities and even whole countries are imposing water restrictions and rationing. But it is often only for households and not the big users of water, leading to charges of injustice. California's Governor Brown has been widely criticized for imposing a 25% reduction in water use by residential and business users, but allowing the big water guzzling agri-farms – which use 80% of the state's water – to go unchallenged.

Already, some governments are making

Photos courtesy of public-domain-image.com

Fresh water may be taken for granted by wealthy populations, in stark contrast to severe drought and water privation in many poorer regions of the world.

choices about whether to allocate declining water sources to people and communities or to promote economic activity in the drive to industrialize as fast as possible. The Indian state of Karnataka, for example, where 80% of the population do not have potable water in their homes, is experiencing such severe drought that almost 10 000 villages are in water crisis. But the state has become a poster child for water privatization, with precious water resources channelled to many new free trade zones and public water taps closed.

Governments are also aggressively seeking out new sources of groundwater and, unless the rules are clear about who has access to these new sources, the fear is that they will go to those with power and money.

For instance, huge new sources of groundwater have been documented in Africa and the fight is on for control of this water. If these sources are not harnessed for the good of all the people and communities of Africa and are allowed instead to become the property of transnational corporations, daily life may not change for the vast majority of Africans who will still have little access to affordable water.

To truly promote the human rights to water and sanitation, our movement and all governments must adopt the public trust doctrine, which underpins in law the notion that water is a commons to be shared, protected, carefully managed and enjoyed by all. Under public trust, water is a common heritage that belongs to the Earth, other species and future generations as well as our own. Governments, as trustee, are obliged to protect these trust resources and exercise their fiduciary responsibility to sustain them for the long term use of the entire population, not just the privileged few who could buy inequitable access.

The public trust doctrine is an important tool to fuse solutions to both the ecological and human water crises. Under a public trust regime, all competing uses of a watershed should have to pass both the tests of fairness of access and sustainability – that is, that their use will not draw down the future capacity of the watershed. Public trust sets the stage for a "hierarchy of access" whereby the human right to water and water for ecosystem protection will take precedence over other uses.

One hugely exciting prospect for human rights in the watershed restoration projects, is the need to employ many millions of people as the work is labour intensive. The Slovakian project, Blue Alternative, put 8 000 people - many of them on social assistance - to work.

Daniel Lorinc photo

Employing local people in need of income to restore a forest watershed in Kladzany, Slovakia. ***Note: See the "Global Action Plan" p. 25, and "Landscape Revitalisation Program," p. 68.***

Providing Answers to the Water Crisis: The New Water Paradigm and the Global Action Plan

By Jan Lambert

Editor's Note: This article also contains five essential terms to know in order to understand the Global Action Plan on page 25.

In the previous article, veteran water activist Maude Barlow has introduced just how serious a crisis is developing around the fact that fresh water supplies are dwindling around the globe, particularly for the poorest populations. She lays out bluntly that it is absolutely necessary for water to be placed under public trust, and that governments must protect the basic human right to clean water and sanitation. Drought is a massive challenge, and is setting the stage for deprivation and ensuing conflicts as nations fight for access to water.

The New Water Paradigm presents a very useful way to view drought and other climate change, a way that shows us that humankind can influence climate for the better, and thus living conditions for all of humanity, simply by allowing nature to take the lead with natural water cycles that regulate climate; it also provides the knowledge foundation for the "Global Action Plan For the Restoration of Natural Water Cycles and Climate," presented at the end of Section One of this book.

If you have read *Water for the Recovery of the Climate– A New Water Paradigm (NWP)*, by Michal Kravčík and four colleagues, then you should be familiar with the following terms. If you have not read the NWP yet, I encourage you to do so, and you can download it right now for free by searching the title on the Internet. However, realizing it is 94 pages, you may not have the time right now, so it is important to become familiar with five basic terms and concepts that you will encounter in the Global Action Plan. Please note the Old Water Paradigm and New Water Paradigm summary chart, which is found on pp. 72-73 of the NWP and is reprinted at the end of this article. As a student of the NWP myself, I have found it very helpful to refer back to it often.

The NWP presents the basic relationship between water and climate, focusing on disrupted natural water cycles as a major factor in increasing global desertification due to climate change. When I checked the internet I found this definition of water cycle: "the cycle of processes by which water circulates between the earth's oceans, atmosphere, and land, involving precipitation as rain and snow, drainage in streams and rivers, and return to the atmosphere by evaporation and transpiration." This seems to be the standard assumption, that there is one water cycle based on moisture from the ocean. This is described in the NWP as the **large water cycle**. The NWP, however, is focused instead on the **small water cycle**, which is defined as the cycle of precipitation which circulates through land and vegetation back into water vapor, which then causes precipitation over the same land. This distinction is vital to realizing the importance of the NWP, because humans have degraded a vast amount of land, causing rainfall and snow melt to be drained from all continents instead of being re-circulated through the land into the atmosphere.

The upshot is that the problems of extremes of weather, that is climate change, can be traced to disrupted small water cycles (small in area, not in importance) that govern local climates everywhere. What is presented is a chronic dehydration of landscapes that occurs locally, but on a global scale. This is closely related to the measurements that indicate that we are experiencing global warming. Instead of attributing global warming solely to buildup of greenhouse gases, however, the NWP emphasizes the drying of land masses as

the chief culprit. This is quite easy to understand once we learn the difference between **sensible heat** and **latent heat**, and the extreme importance of plants. When the sun strikes pavement, a bare crop field, or other unvegetated surface, heat we can feel –sensible heat– will be the result. But when the same sunshine reaches a forest, the trees absorb the sun's rays and the solar energy is used to evaporate water through the leaves, which is known as **transpiration**. Through transpiration, the solar energy has been converted to **latent heat**, with no increase in temperature. This is the essence of regulation of solar energy and climate through the medium of water in all its forms.

By recognizing that all regions must have healthy small water cycles to keep local climates moisturized, energized and moderated, the NWP helps to open our minds to all the ways that water is circulating, not just in the clearly visible rainfall, snow cover and river but where it is out of sight and unfortunately often out of mind– as vapor, underground, in vegetation, and even in our own bodies.

Plants, particularly trees, perform an amazing cooling and moderating role in the small water cycle, as you will read in the next article. The vapor transpired by trees stores solar energy as latent heat. This energy is later released in colder locations, due to condensation of the vapor. Thus temperature differences are moderated in time and space.

As soon as we keep foremost in mind that all water needs to cycle through local and regional ecosystems, and will take care of our needs if we allow it to cycle, we are empowered to take steps to ensure that we do not hinder the natural cycling of this most precious and wondrous natural resource.

Jan Lambert photo

Forests transform solar energy into latent heat through transpiration.

A comparison of starting points and approaches according to the old and the new water paradigm

Old water paradigm	New water paradigm
The water on land does not influence global warming, which is caused by the growth in the volume of greenhouse gases produced by human activity.	An important factor in global warming may be the change in the water cycle caused by the drying and subsequent warming of continents through human activity.
The subject of research is the impact of global warming on the water cycle.	The subject of research is the impact of changes in the water cycle on global warming.
Urbanization, industrialisation and economic exploitation of a country has minimal impact on the water cycle.	Urbanization, industrialisation and economic exploitation of a country (over about 40% of the area of the continents) has a fundamental impact on the influence of the water cycle.
The impact of humanity on the water cycle is negligible and changes in the cycle cannot be reversed by human activity.	The impact of humanity on the water cycle is at present considerable and its changes can go in both directions.
Adverse climatic trends will increase, mitigation can perhaps be expected within a horizon of centuries.	If the new approach to water is applied, a possible recovery of the climate can be expected within decades.
Interest in the large water cycle, which seems difficult to influence, is dominant while the significance of the small water cycle is trivialized.	Interest in the small water cycle dominates.
The reason for extreme weather effects is global warming .	The reason for extreme weather effects are changes in the water cycle.
Global warming and extreme weather effects are inextricably linked.	Global warming can exist without extremes of weather, extremes of weather can exist without global warming.
Global warming is the main climatic problem for humanity.	Extremes of weather are the main climatic problem for humanity.
Vegetation is not ideal from the viewpoint of global warming because it has a low albedo (reflectivity); water vapor again increases the greenhouse effect.	Water and vegetation alleviate unwanted temperature differences; cloudiness moderates the intensity of solar radiation falling on the Earth's surface.
Speaks about the atmosphere as a greenhouse covering of the Earth.	Speaks about the atmosphere as a protective covering for the Earth.
Rising ocean levels are a result of melting icebergs.	Rising ocean levels are a result of melting glaciers on land, but also of a decrease in soil moistures, levels of groundwater and the state of other waters on landmasses.
Rainwater is an inconvenience and needs to be quickly removed.	Rainwater is an asset that needs to be retained in soil/plants[1]
The main source and reserve of water is surface water.	The main source and reserve of water is groundwater.
There is an impersonal attitude by owners and users of land (citizens, companies and offices) towards rainwater in a territory.	A change in the anonymous approach to rainwater on an individual's land and the creation of a spirit of shared responsibility for water resources.
Water is used only once for one purpose and then is sluiced away.	Water can be used for more purposes, then purified and recycled[2]
Water supplied to communities primarily through a system of mains with "potable" quality water.	Water supplied through a system divided into potable and utility water.
Mutual isolation of public policies in relation to water.	Policies in relation to water are based on a thorough perception of water in the scope of a functioning water cycle in a country.
A sectoral approach to managing water resources on land.	Integrated management of water resources in a territory.

[1] „A Paradigm Shift for Water Management". Rocky Mountain Institute, www.rmi.org
[2] ibid.

What Can a Tree Do?

By Jan Pokorný

Jan Pokorný, a graduate of Charles University in Prague, leads research projects dealing with the role of water and plants in local climates. Since 2011 he has been a member of the Research Board of the Technological Agency of the Czech Republic, appointed by the Prime Minister, and a member of the Governmental Inter-Ministry Commission for drought and floods. Outside Europe he has worked in Australia and East Africa, has lectured, tutored PhD students and published about 200 scientific papers.

In connection with global climate change that manifests itself through extreme oscillations in temperature, alternating periods of flood and drought, people are discussing ways of possible climate change mitigation. We ask for an air conditioning device that is generally accessible and can work almost anywhere in the world.

Since this is a truly global problem, maybe the UN should issue the following invitation to tender:

We are looking for an air-conditioning device to be used world-wide that meets the following conditions:

- It is made of durable and fully-recyclable material produced using only solar, strictly no fossil or nuclear, energy. Thus its production contributes to decreasing greenhouse gases levels in the atmosphere, especially carbon dioxide. All the elements of the device are bio-degradable.
- Instead of releasing carbon dioxide it releases a gas that other organisms can use to breathe (ideally oxygen). On the contrary carbon dioxide should be used up in the construction process of the device.
- The device is independent of any man-made energy supply and depends solely on the sun.

Photo courtesy of public-domain-image.com

Illustration: Jana Matysíková

- The device should work in complete silence and produce no exhausts or waste. Moreover it should absorb carbon dioxide, dust and noise. It should improve water and air quality.
- The device should run for a period exceeding a human lifetime. Throughout the whole working period the device should stand up to different weather conditions requiring only minimum and cost-free maintenance.
- It should give shade in summer time and cool the air actively while increasing humidity. In addition it should emit pleasant fragrances in an adequate quantity.
- The device should be available in different models suitable for different climates and must be usable in the tropics, moderate zones and elsewhere. In winter times it could decrease its shade area to let more sun rays through.
- A key condition is its automatic self-regulation with sensors regulating the capacity of solar radiation from zero to 10 or 20 kW. Special attention needs to be paid to the placement and number of regulatory elements to ensure even air-conditioning and to prevent any temperature excesses. The density of sensors should be 10 -100 per mm^2. The device should have a higher capacity in comparison with more usual and more expensive air-conditioning devices that run on electricity.
- Installation and maintenance costs should not exceed 4 Euro a year. The device should require no daily maintenance and its yearly maintenance is not difficult either.
- Since it should operate exclusively on solar energy, its running costs equal zero.
- The device should have a natural and elegant appearance, it should attract birds for nesting and provide food to insects, it should dissipate people's physical and mental tiredness and it should breathe, rustle and release substances with soothing effects.

Well, has the advertiser gone crazy? No! We all know such a device and it is easily accessible. It is a tree! A tree supplied by water. Take a look for yourself:

A tree with a crown of 5 m in diameter covers an area of cca 20 m^2. On a sunny day, at least 150 kWh of solar energy fall on the crown. What happens with this energy? 1% is used for photosynthesis, 10% is reflected in the form of light energy, 5 – 10% is released as heat and the same percentage is used for heating up the soil. The largest percentage enters the process of transpiration whereby water vapour is released from the tree. If a tree has a sufficient water supply, it can evaporate more than 100 litres of water a day. In order to evaporate 100 litres of water, approximately 70 kWh (250 MJ) of solar energy is needed. This energy is absorbed in water vapour and is released again during the process of condensation to liquid water. In order for 1 litre of water to be evaporated, 2,5 MJ (0,7 kWh) is needed – this is the latent heat needed for

phase transition between the liquid and gaseous states.

On a normal sunny day, a tree transpires around 100 litres of water, thus cooling its environment by cca 70 kWh; during a ten-hour period the tree cools its environment with a 7 kW power output. Just for comparison, an air conditioning system in a five star hotel has power of 2 kW, usual fridges and freezers even more than ten times smaller. Moreover, an A/C system, a fridge or a freezer heat up its surroundings with the same capacity with which they cool down the area within. The water vapour released from our tree heats up cool places on which it condenses.

Still more extraordinary is the regulatory capacity of a tree and the fate of the solar energy absorbed in the water vapour. A leaf has a number of pores (stomata) through which water passes and which regulate the speed in which water evaporates (or cools) depending on the total amount of water available and intensity of solar radiation. 1 mm^2 of a leaf's surface contains about 50 – 100 stomata, each reacts to the temperature and air humidity of its immediate surroundings and opens or closes accordingly. Each tree therefore contains tens of millions of stomata – effective regulatory valves with temperature and humidity sensors. Can you imagine the amount of cables, wires, and sophisticated technology we would need to construct such a device?

The vapour rising from the tree contains absorbed solar energy and as it travels through the countryside it condenses on cooler places and thus releases latent heat. In this way solar energy flows through space and equalizes temperature differences. Depending on physical conditions, water vapour can condensate in the morning as dew or soft morning rains and through exchanging the latent heat it warms up the environment. Solar energy thus travels not only in space, but also in time.

After this brief review of elementary physics we can understand better the difference between the shade of a tree and of the shade of a parasol or a roof. The difference is great. A parasol reflects sun's rays only passively (depending on the colour of its surface), a tree transforms them actively into coolness and humidity. The only thing the tree needs in order to work well is occasional watering. Moreover a deciduous tree growing in front of a window sheds its leaves before winter and more rays reach our window and warm up the building passively.

A tree cleans water, first by the process of distillation through stomata, second by its roots which take nutrients from the soil and support lower organisms that take other substances from water.

Through management of water and plants we influence the climate of our garden and its immediate surroundings. Through artificial drainage and elimination of green spaces on large areas, especially in cities or in fields, people create desert climate that cannot be compensated by any technological device. This is caused by the fact that on surfaces without vegetation most of the solar radiation is transformed into heat that warms up and dries its surroundings. Solar radiation reaching a small garden of 300 m2 on a summer day has the power of cca 300 kW, in total about 1 500 to 3 000 kWh of solar energy a day. On dry surfaces without vegetation, the same amount of energy is released as heat.
However if the surface is covered with vegetation and supplied with water, more than a half of the solar energy is absorbed in water vapour and our watered garden with trees and other plants cools itself and its surrounding down by 1 000 kWh. It does so noiselessly, inconspicuously, accompanied by bird song, scent of flowers and ripening fruits. If we were to pay only for the energy used for running of a comparable device, it would cost us about 150 – 300 Euro a day!

We have at hand a useful air-conditioning apparatus in many different forms – be it spruce, oak, birch, apple tree, eucalyptus, baobab, sequoia, or trees of tropical rain forests covered by epiphytes and lianas - that can mitigate global climate change and help us fight global warming.

For each molecule of carbon dioxide absorbed by a tree or other green plants one molecule of oxygen is released into the air. Trees moreover release other organic substances into the air, e.g. terpenes that are beneficial to people's psyche and can act as antidepressants.

A Global Action Plan for the Restoration of Natural Water Cycles and Climate

By 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/.

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 freshwater 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 rainwater, 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

[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

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.

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

[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
[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

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].

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

[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
[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

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 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

[20] see Definition of Terms, Appendix

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

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 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 al-

Jan Lambert photo

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

leviate 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.

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

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

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 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.

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 dol-

[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
[29] http://www.goldmanprize.org/1999/europe

lars, 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].

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.

[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

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.

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 cli-

mate. 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 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

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

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.

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:

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.

✓ 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.

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 multisectoral 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.

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 protect, 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 landscapes:

- ✓ 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, organization 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 determining 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 to government structures.
- ✓ The legal form of effective professional management of the program will consist of (i) managerial management (an executive body) and (ii) effective monitoring and controls (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.

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

[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.

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 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 agrotourism 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 cool-

[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

ing 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 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

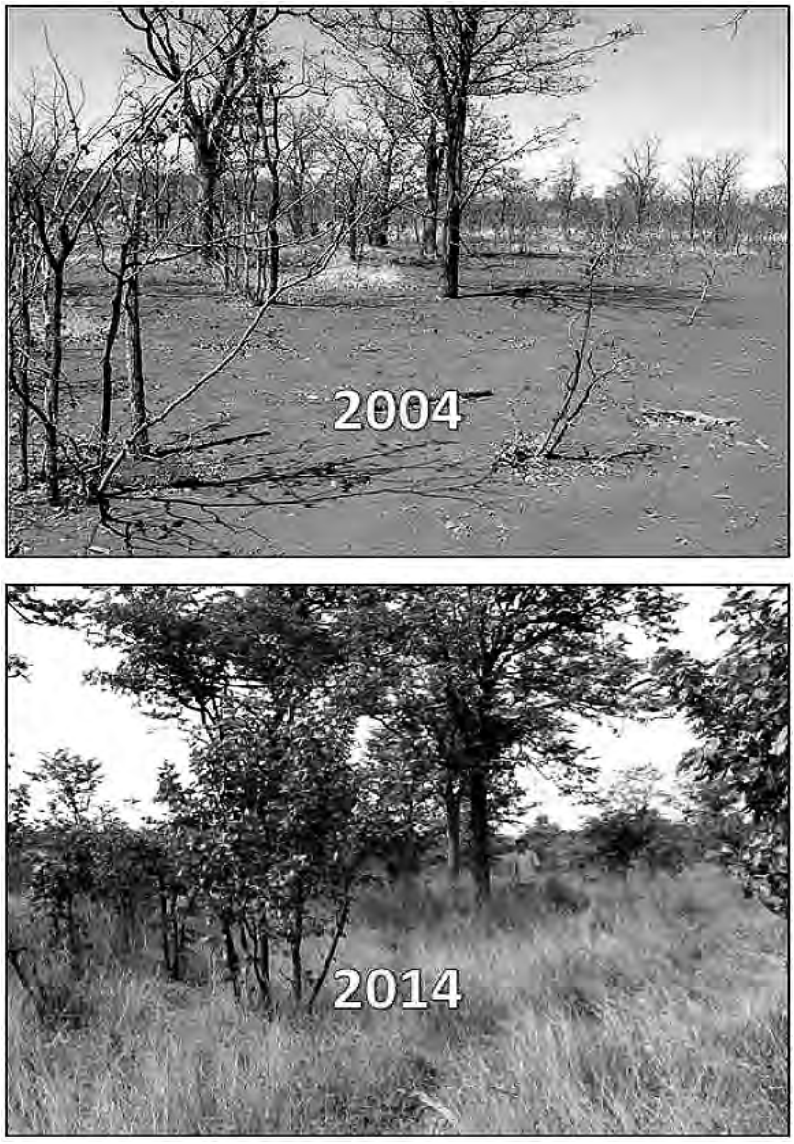
[38] For example ,in the US market a number of companies offering innovative products and services, particularly for the urban green infrastructure (green roofs, rain gardens, etc.) are already established.

[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.

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



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.***

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.

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.

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

[40] The numeric representation of the macro-economic benefits and costs of GAP listed in this section are based on cautious, conservative technical 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.

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 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, techni-

[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.

cal 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.

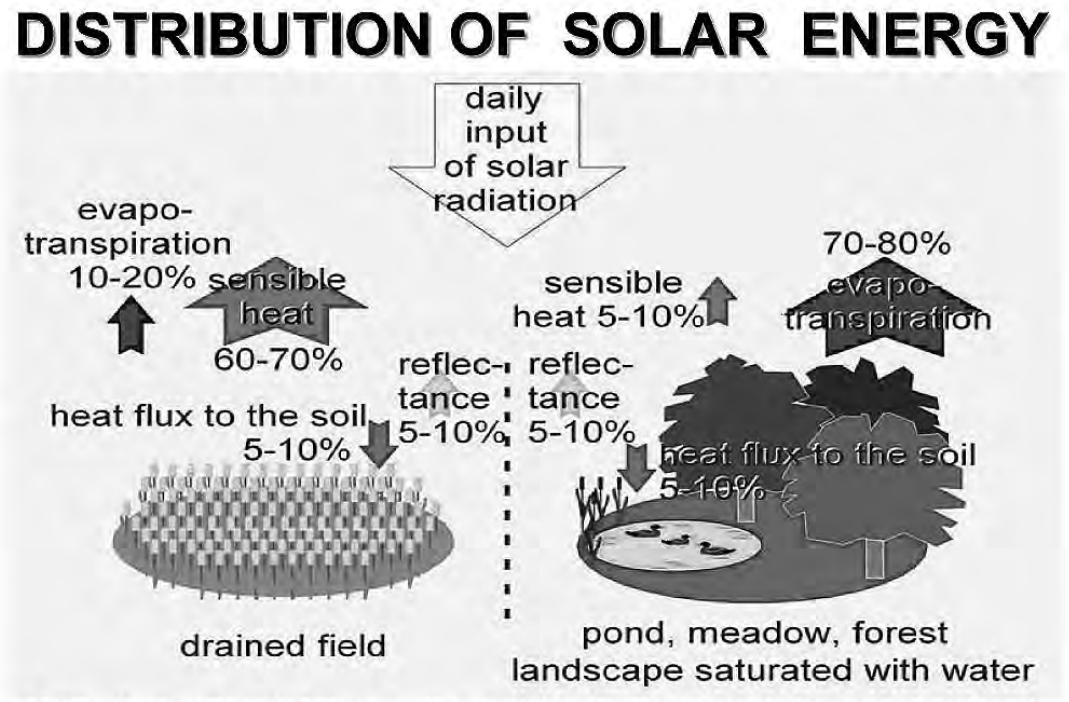
8.2. Overall Benefits of the Global Action Plan

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

Catching the Rain For Natural Water Cycles and Restored Landscapes

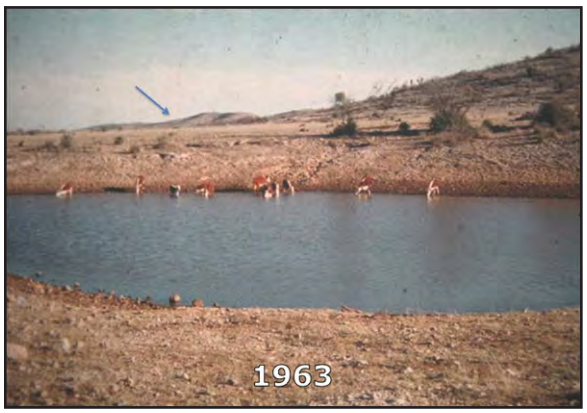
Photos courtesy of Charlotte O'Brien

FORESTS: Through their transpiring of water vapor, forests provide a maximum restoration of natural local water cycles. In Vietnam, the residents have been planting and tending fast-growing bamboo to regenerate forests destroyed by the Vietnam; War. ***See "Bamboo– The Fastest Way to Grow a Water Cycle," p. 62.***

Mexican Ranch Restored With Holistic Planned Grazing

By Karl Thidemann

The Las Pilas Ranch in Coahuila, Mexico, is a model of ecological restoration using Holistic Planned Grazing (HPG). Starting in 1978, the livestock population was doubled and HPG replaced conventional grazing. By 2003 the land had six times the water holding capacity, water being held in the soil, plants and trees. The watering hole in first photo is no longer needed because previously dried-up streams have returned to year-round flow. See http://www.planet-tech.com/blog/land-restoration-holistic-management and http://planet-tech.com/blog/las-pilas-ranch.



Photos by Guillermo Osuna

HOLISTIC PLANNED GRAZING: Photos taken from the same spot, at Las Pilas Ranch, Chihuahuan Desert region, Mexico. The arrow marks the same point on the horizon.

Photos courtesy of Glenn Gall

PERMACULTURE NO-TILL: Glenn Gall, left, and Teel Marcum, on tractor, of Ann Arbor, Michigan (USA) use a keyline plow to break up compacted subsoil, with minimal disturbance to the surface topsoil layer. This allows air and water to penetrate, creating a more suitable environment for root growth and deeper topsoil.

AGRO-FORESTRY: Your choice of coffee makes a difference. Shade grown coffee in Nicaragua utilizes a forested land cover that helps to preserve moisture in the landscape and atmosphere as well as provide a living for farmers growing premium coffee, and habitat for migratory birds from North America. Photos and information from Bill Wilson, http://www.birdsandbeans.com/

Photo courtesy of Tamera

ARID LANDSCAPES: At Tamera, a research station in Portugal, constructed lakes collect rainwater for agriculture and wildlife habitat. ***See "Decentralized Water Retention" p. 58.***

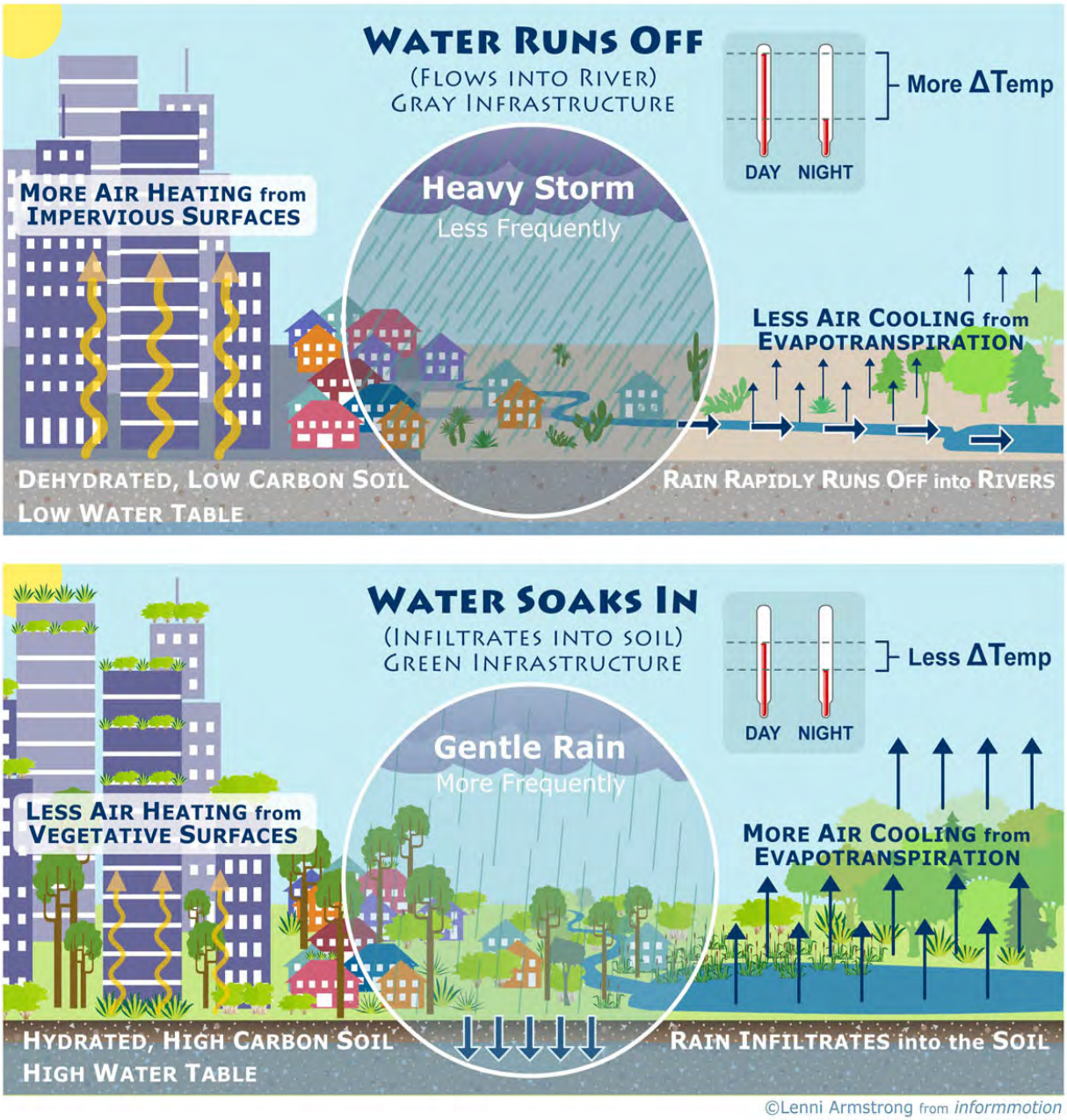
Jan Lambert photo

URBAN RAIN GARDEN: In Keene, New Hampshire (USA), a conventional storm sewer has been replaced with a stormwater grate that directs street runoff into an attractive rain garden. ***See "From Grey to Green," p. 81.***

Photos courtesy of E. J. Prescott, Inc.

GREEN INFRASTRUCTURE TECHNOLOGY: Installation of turf reinforcement mats in Illinois (USA), right photo, cured a severe stormwater erosion and pollution problem, left photo. Likely alternatives would have been more expensive and less environmentally-friendly concrete or stone. ***See "From Grey to Green," p. 81.***

Which Will We Choose?



©Lenni Armstrong from *informmotion*

**FROM GRAY INFRASTRUCTURE TO GREEN INFRASTRUCTURE: "*The New Water Paradigm" on p. 21* offers a framework for transforming conventional stormwater management, which treats rain as a waste product, to an environmentally friendly, climate-restoring approach that treats urban rain as a valuable resource. *See additional illustration, "Water and the Soil," on p. 85*, and *"Hosting a Depaving Party" on p. 86*. More at informmotion.biz.

SECTION TWO
The New Water Paradigm in Action

Retaining the rain in the land, whether in forests, grasslands, farm fields, or urban areas, has similar benefits throughout the landscape. The articles in Section Two highlight examples of how and where water restoration is happening now, or could happen, keeping in mind that following the example set by nature is always the best guide.

Rainwater, snow melt, and stormwater are all terms for precipitation, and for best management we should collect and infiltrate all precipitation into the soil and vegetation, or small water catchments, wherever it falls. Ideally precipitation on land is captured by virgin forests, wetlands, beaver ponds and meadows and other natural landscapes. The best humans can do is to mimic nature.

Jan Lambert photo, USA- NH

Natural areas with a variety of plants and animals are the ideal place to cycle rainwater. This small wetland isolated within a forest was originally created with a dam built by beavers, now filled with vegetation (right side). The rain is gradually released into the earth and the local water cycle.

Decentralized Water Retention and Regeneration of Small Water Cycles: Not Just a Model for Southern Europe

by Leila Dregger

Tamera is a 330 acre alternative research community in Portugal that showcases an impressive example of natural and decentralized water management. After a few years, nature has visibly recovered and biological diversity is increasing year by year. The land is again ready to yield food in every season. Similar examples from Slovakia and India show that the principles of Tamera's water retention landscape can be adapted throughout the world. More at www.tamera.org; see color photos p. 58.

Water shapes any landscape. When land is replenished with water, the water is absorbed by vegetation and the earth, where it is stored and slowly released again. Wealth and abundance then emerge rather than scarcity and poverty. Where there is enough water, not only does life recover, but the economy also thrives. Access to water is one of the key factors for investors and businesses. William Cosgrove, former vice president of the World Bank and later president of the World Water Forum, said during his visit in Portugal, "States which are hit by desertification and droughts will become more and more dependent on those which have enough water. In the future, the world will be divided into water-rich and water-poor countries. Water is already the world´s most important currency."

But the capitalistic view on water has made it a commodity to be stored, dammed, channeled, sold-out and artificially made scarce. Nearly one billion people throughout the world lack sufficient access to drinking water. Every year, more than a million children die of diseases caused by lack of fresh water. The groundwater tables are lowering all over the world; wells are drying out, and rivers and oceans are turning into sewage dumps. Water, as many experts say today, is a key factor in climate change.

In Southern Europe, entire regions are being abandoned. Lacking water to feed animals and irrigate fields, farmers are giving up. The cause behind the changing rain patterns can be found in deforestation and overuse: barren, hard soils can no longer absorb the winter rains, and water runs off in wide streams, taking precious topsoil with it. While summer droughts make farmers desperate, winter floods destroy roads and houses. The usual measures— large dams, sealing of landscapes, channels, and drainages—are evidence of a faulty paradigm, that is assumptions about water management, as more and more water experts are beginning to understand.

Bernd Müller, Tamera's water expert, suggests learning from nature in order to find sustainable solutions. He explains, "Nature provides enough water for all people and animals, if we follow the logic of nature rather than the laws of capital." Under the guidance of permaculture specialist and mountain farmer Sepp Holzer from Austria, Bernd and his team have created a water retention landscape on 150 hectares, and with that, a model for ecosystem regeneration which can be applied not only in Southern Europe, but in other regions as well.

In the summer of 2007, the site of Tamera was faced with conditions that were typical for Southern Portugal: hot, dusty, bare earth. The hardy Grey Cistus seemed to be the only plant able to sustain the heat. The winter rains had eroded the fertile topsoil. Aquifers had dried up, and the fire hazard was high.

But today, the situation has changed dramatically. Even during the summer months, a

perennial creek is flowing again. Ponds, lakes, and ditches have filled in during the winter. Shady little nooks under bushes and trees invite passersby to rest. Frogs, crabs and ducks feed in their habitats along the shores. Children play at the mini-beach. Vegetables and fruit trees grow on the shore terraces even at the hottest time of the year. The soil is covered with clover and mulch, and contains enough water even in summer. When irrigation is needed, the lake is close by. A cormorant waits on a rock island for an unwary fish. We have even seen a family of otters.

So what happened to cause this amazing transformation? In March 2007 the Tamera community invited Sepp Holzer as an advisor. This "rebel farmer" dispelled the illusion that Portugal is a dry country. There is an abundance of rain, but it falls all in one season. According to Sepp, "Water is the most precious resource a locality can have. A farmer who lets water flow away is like somebody who throws money out the window."

His proposition for Tamera? "Build ditches, lakes and ponds full of fish, and you will have more vegetables at the shores than you can eat, without using concrete or plastic, just the natural material which you find here."

The Tamera team dared to follow his advice. At the tightest part of the valley, they used excavators to dig a ditch two meters deep, filled it with loam and clay found in the valley, and rolled over it with heavy gear, compacting it over and over again. In this way, they built an earth dam, layer by layer, up to the height of the future lake. They covered it with mixed soil, shaped it in a natural-looking way and planted trees on it. Behind the dam, the winter rains filled a space of several hectares and 12m depth in just a few months. The place where they took the soil for the dam became the deep zone of the lake.

Today, Tamera has ten lakes and ponds and many swales, (ditches built along contours),

Simon du Vinage photo

Sepp Holzer, permaculture expert who inspired Tamera's Water Retention Landscape, standing near one of the lakes amid fields of fruit and vegetables.

keyline fields and terraces. We also retain the flowing rainwater, giving it time to infiltrate into the soil. Keyline can be seen as a collection of design principles, techniques and systems for development of rural and urban landscapes. Keyline design was developed in Australia by farmer and engineer P. A. Yeomans, and described and explained in his books *The Keyline Plan, The Challenge of Landscape, Water For Every Farm and The City Forest*.

Sepp Holzer states, "Storing water in tanks makes no sense. Like any living being, water needs to be able to move. That´s why a lake or a pond should look as if it had always been there, naturally, with sinuous lines instead of corners and straight lines. It should have deep and shallow zones and planted shorelines to attract diversity, to be moved and thus clean itself."

The lakes at Tamera teem with fish, including predators. Hiding places for young fish help create a natural balance. Heavy rocks, half submerged in the water, store the heat of the day and release it during the night, creating niches for warmth-seeking creatures and plants. The fields at the shoreline terraces produce vegetables throughout the entire year. Even during the summer, they require little irrigation, because their locations close to the lakes allow their roots to reach down to the wet layers of soil. And if needed, water for irrigation is not far away.

How can the lakes retain water even in the absence of sealing with concrete or plastic?

Bernd Müller answers, "A part of the water does infiltrate into the ground, but very slowly. And this is actually the purpose of the lakes: slowing down the runoff of the water." It is not about storing water, it is about reactivating the local water cycle," he explains. "We can already feel that the landscape and the air are much more humid than before. This is because the water not only feeds the earth body and the plants, it also evaporates and thus creates a different micro-climate."

Soil replenished with groundwater is also a precious effect of the water retention landscape. "All our measures have the purpose of giving water time to infiltrate even the hardened soils until it reaches the aquifers. There, the water can ripen and mineralize until it is ready to come to the surface again in springs or through plants."

Meteorologists have proven that small, local water cycles maintain the rainfall and air humidity that plants need to grow. But these same small water cycles die out if there is no vegetation. Bernd adds, "Forests and scrubland absorb rainwater, return it to the atmosphere via evapotranspiration, and thus cause more rain to fall. Therefore, vegetation is the engine of the local water cycles. As many regions have become deforested, we have to help the land regain its ability to move water. Then, the land will become fertile again."

Bernd's colleague, Christoph Ulbig, adds, "The lakes are beautiful icons of our work, but the actual effect is the result of the many little things we do: reforestation, working the ground

Leila Dregger photo

Hydrologist Michal Kravčík of Slovakia conferring with Bernd Walter Müller, who is the ecologist of Tamera and responsible for building the Water Retention Landscape. The water in the background is part of a large area of ponds, lakes, swales and other waterholds to store the winter rainfall and enable it to infiltrate into the soil again. Built in 2007, the project has had positive effects in reversing desertification in Southern Portugal.

parallel to contours, and other means which slow down the runoff of water and regenerate the small water cycles. And anybody can do those things."

In a water retention landscape, instead of rainwater it is spring water that flows off the land. This improves the value of a landscape immeasurably: Large dams are unnecessary; the danger of floods or brush fires is reduced; farmers can cultivate. Ponds and lakes offer many additional economic possibilities, such as fish farms and the cultivation of water plants; even recreation and tourism are possible.

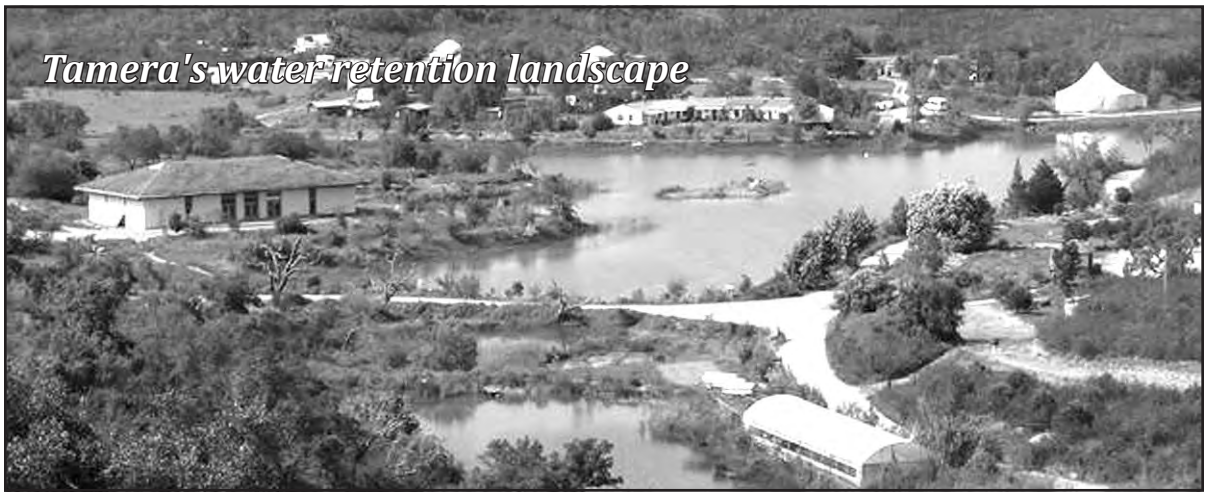
Bernd Müller states, "Water is always the first precondition for the recovery of a region, including its economy. Those who understand and follow the logic of nature will strive for a decentralized, sustainable, diverse economic region, not a centralized organized monoculture."

Bernd Müller has also become a consultant for areas hit by natural disasters. "Water is also a key factor in reconstruction following disasters. Without water, there is no life, no hygiene, and no cultivation. One of the first measures after a natural disaster or war is the regeneration of a healthy water balance. I want to support this process to take place as sustainably and naturally as possible."

Tamera's water retention landscape model, based on the principle of enabling rainwater to infiltrate the soil, can and should be applied worldwide. In the Eastern European nation of Slovakia, hydrologist Michal Kravcik did not agree with the standard strategy of building big dams. With his organization "People and Water," he created a nationwide program of decentralized water retention. In countryside, forests, and villages, residents started to build check dams and other measures to slow down the water runoff. The creation of this alternative to large dams was able to save 24 villages while keeping water on the land.

Another example is given by Rajendra Singh of Rajasthan, India, who is popularly known as the "Water Gandhi." The Alwar district was formerly an intensive production area for cereals, but overuse and deforestation started the process of desertification. Rivers dried out, and people left the region. The Thar desert seemed to swallow one village after another. Rajendra, a doctor, inspired the population to build simple waterholds and check dams at many places, using rocks, wood, clay, and anything else they had to slow down rainwater. After having built 8,600 such water holds, the initiative is now able to supply 1 000 villages with water. Five rivers that had dried out are flowing again throughout the year. Rajendra's work earned him the Stockholm Water Prize in 2015.

These examples demonstrate that a different approach to water management can buffer the effects of overuse, monocultures and deforestation, and prepare the ground for worldwide ecosystem regeneration, for the revitalization of regions, and for an alternative to economic globalization.



Simon du Vinage photo

Bamboo-The Fastest Way To Grow a Water Cycle

By Charlotte O'Brien

Charlotte O'Brien, author of the following two articles on bamboo and biochar, is a pyrolysis and biomass expert who has worked for years with many varieties of bamboo, a plant that improves soils and water cycles, expands habitats for many other species, and may be harvested sustainably for uses ranging from construction to food to biochar, a soil supplement. She recently founded Carbon Drawdown Solutions, (www.cdsbiochar.com/) supplying equipment for local biochar processing for long-term soil carbon storage and greatly improved soil health, water retention, and productivity. She is also founder and director of the non-profit BioBamboo (www.biobamboo.org).

The flooding of the Indus River in Pakistan in 2010 was devastating. As the rains continued day after day nearly everyone was blaming climate change for the disaster. But high rainfall generated by an out -of- balance water cycle was only part of the story. It is not just how much water falls; it is how much water does not infiltrate that is the real issue. If the hillsides along the Indus River had been full of forests, as they once were, the driving rain would have been softened by the forest canopy before it hit the vegetated hillsides, bouncing from plant to plant and infiltrating into the carbon- rich humus of the understory. But rampant deforestation resulted in barren tropical soil that for many years had been losing its carbon- based "glue" due to exposure to the severe sun of the tropics. Without the sticky carbon and plant cover the weakened soil eroded as raindrops gathered like an angry crowd, collecting into gushing streams with nothing to slow them down.

If it were not for human mismanagement tropical soils would never lay bare in the beating sun. Bare soil is not natural, yet it is happening all over the world; it is causing a severe loss of soil carbon, soil health and a loss of local water cycles that "prime the pump" of the larger water cycles. Some calculations hold that 50% of the CO2 in our atmosphere has been released from the soil in recent history, either from deforestation, overgrazing or use of agricultural chemicals. This has resulted in soils that resist water like hardened cement; the diminished carbon sponges provide little space underground for infiltration. If water does not have a home in the

Courtesy photo
Bombed portion of the Ho Chi Minh Trail, used during the Vietnam War (1954-1973) by the North Vietnamese as a route for troops and supplies to get into the South. When the war was over local people could earn two pounds of rice per day in return for planting bamboo.

soil then it is not available to transpire through the plant cover, gently rise as soft mist and so play in an endless local water cycle that adds to regional water cycles. Once the soil becomes severely degraded it is very difficult to bring it back to balance, and often desertification occurs.

But there is hope for tropical soils in trouble- the powerful pioneer plant, bamboo. Bamboo is a wonderful tool in the hands of a skilled rejuvenation expert, because it can establish even on badly degraded hillsides. Bamboo can establish itself on bare ground and within five years provide the type of full shade that is needed in the tropics for an understory ecosystem to flourish, while at the same time beginning to give marketable products. Bamboo readily transpires, cycling water from the soil to the atmosphere; it has been shown by the United Nations to raise the water table, increase water infiltration and improve the local water cycle. In addition to providing shade, when bamboo goes dormant during the dry season it drops its leaves for a moisture barrier, feeding the microbes and earthworms while contributing to humus development.

Mature construction grade bamboo will yield 30 tons of harvestable bamboo per hectare per year for roughly 60 years. At the same time it is adding carbon to the soil via the growth of its root rhizomes; it is also feeding soil fungi via what Australian scientist Dr. Christine Jones calls the "liquid carbon pathway." It is this symbiotic relationship with soil microbes that allows bamboo to transform an ecosystem with incredible speed. The bamboo can get going on very little while it creates a habitat for and nurtures the microbes, earthworms and understory that ultimately allow all to thrive in the true spirit of cooperation. The restoration of the soil microbes allows the soil to quickly absorb heavy rains while resisting erosion during severe weather events. Good soil health is what ultimately drives the water cycle by continually increasing the soil's ability to hold water for the plants to transpire. The solution to water cycle imbalance occurs in the soil. We must stop treating soil like mere dirt and instead recognize its complex interrelationships with water, living organisms and ultimately climate. *See color photo p. 53.*

Charlotte O'Brien photo

Today mature bamboo forests in Vietnam improve ecosystems and provide wood for building, paper and chopsticks.

Biochar-The Underground Water Magnet: Hope For Soil and Water Restoration

By Charlotte O'Brien

Soil is the reservoir for the water that makes up a good portion of our local and non-local water cycle and soil carbon is what allows soil to hold larger amounts of water. Each 1% carbon increase in the soil results in an additional 16,500 gallons of water available to plants. To the climate-conscious gardener that means 1.5 quarts of water per cubic foot of soil.

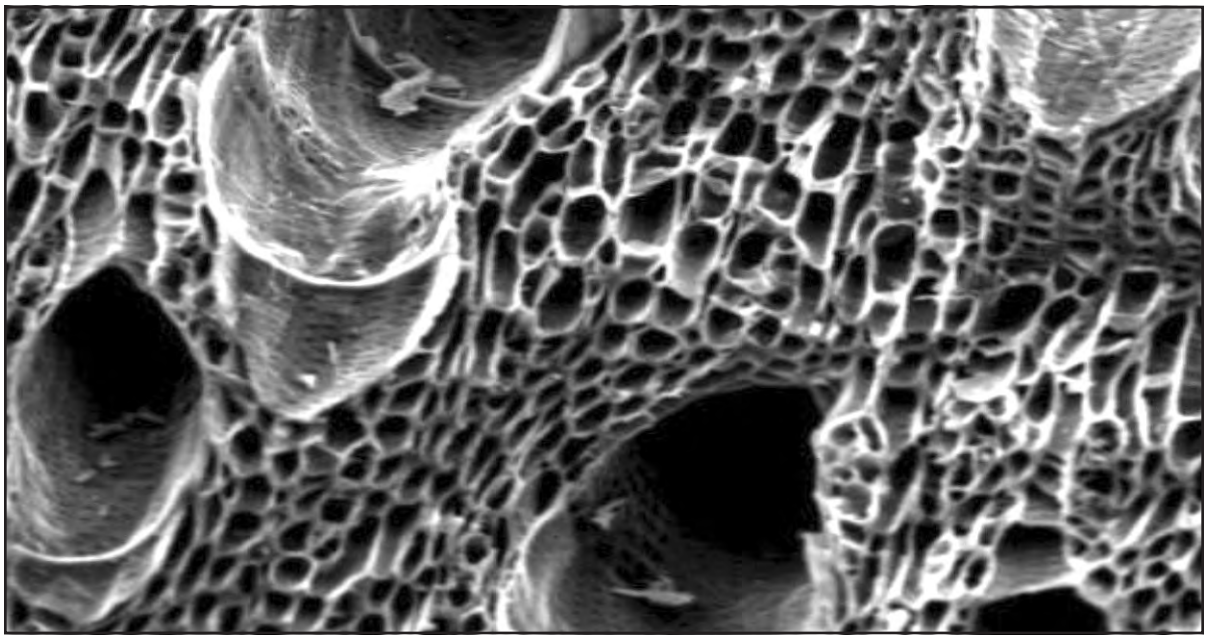
One way to quickly increase the carbon in any soil is to add biochar, which is a type of high grade charcoal that attaches to both positively and negatively charged ions. Biochar is approximately 75% pure carbon and when added to the soil it increases the water holding capacity immediately. But more important for the restoration of global water systems is biochar's ability to kickstart the continuous addition of carbon to soil via what Australian scientist Dr. Christine Jones calls the "liquid carbon pathway," a symbiotic relationship between plants and fungi that sequesters significant amounts of atmospheric carbon into soils on an ongoing basis, in the form of glomalin. This sticky substance is what gives soil that crumbly feel when handled. Soil particles that stick together create voids that allow water and air to infiltrate the soil and make it healthier for the plant and all soil life. It is this sticky carbon that allows large amounts of rainwater to infiltrate the soil. Soil lacking carbon becomes hard and water starts to flow over it rather than sink in. This is key to the problem of out-of-balance water cycles as well as food security. Agricultural chemicals kill the microbes that make glomalin.

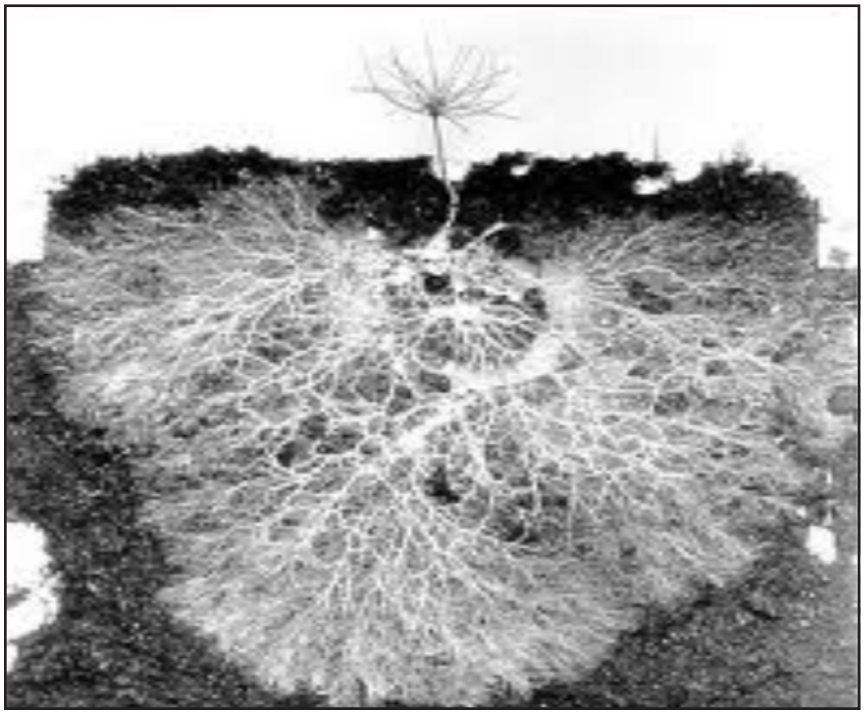
The liquid carbon pathway is beneficial to both plants and fungi. A plant will photosynthesize in excess of 50 to 60% of its own needs and exude extra long chain carbon sugars down to its associated mycorrhizal fungi. The plant is the fungi's sole source of food and in turn the fungi transports needed mineral nutrients back to its host. In a process totally overlooked by the agrochemical industry, the fungi and their bacterial "buddies" extract nutrients from the soil's rocky parent material, by using enzymes. The fungi will actually trade sugar with the enzyme-wielding bacteria for the nutrients that were formerly unavailable to the plant. In drought conditions water becomes tightly held in soil and cannot be accessed by the plant's large roots. During these times the fungi use their tiny hyphae to extract this valuable water and transport it back to the host plant, allowing fungi-associated plants to survive when their unassociated cousins cannot. Biochar has been shown in a meta-analysis to increase the growth of mycorrhizal fungi by 56%.

It is estimated there are 1.8 million square miles of abandoned lands globally that once produced food via crops or animal pasture. With 5.6 million square miles of cropland left remaining, not only is this a loss to food production but also to water cycles. What would it take to get this large acreage back into a vegetated ground cover that would cool the soil and the air above while supporting a local water cycle? Whenever depleted soils are abandoned, it can be assume that the microbial life is dead and that the soil will need to be re-inoculated if it is to succeed in re-establishing ground cover. Biochar is ideal for this task as it can be an inoculated carrier of the missing microbes, the micronutrients that will be needed by the microbes as well as edible carbon, water and shelter. Biochar is a tiny shelter that enables mycorrhizal fungi to pioneer new territories.

If as a civilization, we are ever to get busy fixing the environmental mess we have made, we are going to have to involve the large scale

production of biochar in a cycle of rejuvenation, bringing back abandoned soils while increasing biomass production and using it to make more biochar. In crop production biochar acts as a bank, making soil nutrients available for plant uptake. At the same time it immobilizes soil toxins, making them biologically inactive and unable to suppress soil activity. This is an important attribute for converting soils made toxic from chemical agricultural practices to the new "regenerative agriculture." If the non-profit, Pro Natura can grow 100 000 pounds of vegetables on an acre of the Sub-Saharan Desert by using biochar, then it can be done anywhere. It is a matter of making good quality biochar, inoculating it, and keeping the ground continuously covered with vegetation. Thus the local water cycle will naturally return.





Courtesy photos
TOP: Microscopic view of biochar.
BOTTOM: mycorrhizal fungi.

River Regeneration and the Reviving of Community

By Minni Jain

In 1985 Rajendra Singh, inspired by Gandhi, went to live in dry and arid rural Rajasthan, India, with the intention of introducing modern education and medicine to that impoverished area. But soon the villagers made clear their primary need was for WATER. Over the next few years, harnessing the villagers' traditional wisdom, the river systems in the region were regenerated, **dramatically transforming that arid land into a lush, green area of well-being and productivity.**

The river in 1985 before TBS' interventions

What was done: Over 28 years, **7 entire river systems**, previously dried up for 80 years, were revived. Over 10,000 Johads (small earthen dams) were built by the villagers at strategic places. Underground aquifers were recharged, rivers began to flow again and food supplies were secured helping those villages to become thriving communities again. Now the project is being replicated across India.

Building a johad

How it was done Tarun Bharat Sangh (TBS), the organisation that Rajendra set up for this work, began its work in the village by nurturing the Village Council, a traditional body comprised of representatives from each household, where all decisions are taken by consensus. Here, villagers agreed to contribute resources (labour and materials) towards building the Johads, thus developing their sense of ownership and ensuring their ongoing commitment to maintenance. The first fruits of their labours were realised in the very next rains when the river began to flow again.

Outcomes of applying this strategy of facilitating community-driven decentralised water management & conservation:

- it encourages disciplined use of natural resources, ensuring sustainable water availability
- creates an increase in agricultural and milk production, thus ensuring food security
- restores the area's ecology
- regenerates healthy, prosperous communities
- strengthens democracy and political transparency and even changes government practices
- ***its overarching vision of recharging the groundwater on the planet delivers long lasting, proven, comprehensive transformation of communities***

The river regains its rightful position as the physical and spiritual centre of life.

The method addresses two separate universal problems:

1) Communities everywhere are losing the capacity and will to fend for themselves; and
2) Communities are increasingly threatened with shortages of natural resources, even in the developed world.

The river today

These issues are resolved holistically at community level by applying the community's inherent capacities to address endemic problems.

Working with actual communities, TBS has shown that rather than imposing generic global solutions, facilitating the flow of traditional wisdom as well as introducing appropriate modern knowledge will resolve issues like river flow and further strengthen their capacity to adapt to other threats such as climate change.

If you wish to comment on this paper, or enquire about the work, please contact us:

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'Johad' type flow-intervention structures to manage floods in the UK

(Johads are small bunds/dams which TBS builds in India to revive rivers from drought)

The village of Belford in Northumberland, UK, with a population of about one thousand, had a long history of flooding from the Belford Burn, disrupting its life on at least five occasions in the four years before 2007. The catchment to Belford is 10km^2 and ranges from upland pasture to lowland arable farmland.

Whisky barrel 'bund'

What was done:

As funding for a traditional flood defence scheme could not be justified, the Northumbria Regional Flood Defence Committee allocated funding to implement a catchment management scheme to construct dozens of flow intervention structures in the catchment upstream of the town. This was the Belford Catchment Solutions Project – a partnership project between the Environment Agency, Newcastle University and Local Landowners.

26 interventions that trap sediment, improve water quality, create new ecological zones and slow the flow of water were trialled and built which successfully held water upstream from Belford during the next flood.

The principle was ***INTERCEPT, STORE, SLOW, FILTER***

'Bund' creating off-line pond

The ***bunds*** or interventions created online ponds (on the course of the river), offline ponds (adjacent to the river). These ponds work by storing water when the river is high and releasing it slowly back to the river after the peak has passed. ***Bunds*** were also built across the overland flow routes. These intercept fast flow pathways of flood water, preventing run-off from reaching a water course too quickly. Large woody debris and other features were also installed which slow the flood peak and divert it onto the floodplain.

'Flooding has stopped completely in Belford' *(local resident/2014)*

'Bund' being constructed across primary flow pathway

Outcomes of applying this strategy of collaborative water management

- Reduced flood risk downstream
- Reduced levels of pollution
- Habitat creation
- Increased biodiversity
- Increased farm productivity

Traditional flood defence govt estimate for Belford: £2.5 million
Actual Cost of Belford Project: Approx. £200,000

Satellite image 16th Feb 2014 showing soil run-off to the sea i areas worst affected by the winter floods *(Dundee Sat Stn)*

The method addressed two major problems:

1) It brought the local landowners, the council, the environment agency, local residents and scientists together to arrive at a long term, really effective solution to the flooding.

2) It arrested the run –off of the best soil of the area, ***improving*** its ecology and fertility.

Catchment management by building interventions at strategic places in the landscape to retain water upstream has been implemented successfully in other places too eg. in Pickering/Yorkshire. It is an effective, small-scale, sustainable and community –level approach for many other flood risk areas, including the Somerset levels. This approach could help reduce flood risk in the riparian areas of the UK ***at a fraction of the cost, time and effort.***

If you wish to know more about this work, please contact us:

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The Landscape Revitalisation and Integrated River Basin Management Program

A Slovakian Case Study
By Richard Widows

Richard Widows is an agricultural scientist with ten years professional experience in the agricultural sector, with a particular focus in agricultural policy. He has recently completed a Masters in Holistic Science at Schumacher College in the UK. He works with the UK based Water NGO, the Flow Partnership.

The Slovakian Landscape Revitalisation and Integrated River Basin Management Program was adopted by the Slovakian Government on October 27, 2010. It was founded on the principal understanding that changes to the national hydrology, particularly as a result of more industrialised approaches to agriculture over the past five or so decades, had dramatically reduced the capacity for water to be held in the Slovakian landscape. Therefore, the program's primary focus was to increase the water retention capacity of the landscape.

To achieve this objective, the program set a goal of restoring landscape water retention capacity of at least 250 million m^3, focusing on damaged parts of the landscape, thereby achieving flood and drought mitigation outcomes simultaneously. The public cost for achieving this objective was set at 4€/m^3 of water retention capacity of an element, measure or system. Therefore, the ultimate public cost for flood and drought proofing the entire Slovakian landscape was set at 1 billion euros over a period of 10 years.

In a short period of just 18 months, 488 villages and towns were involved in the program. In total, about 100 000 individual water retention elements were carried out with a total landscape water retention capacity of approximately 10 million m^3. This amounted to 4% of the overall objective during the expected 10 year implementation period for the program.

Provided by Michal Kravčík

Satellite map shows the extent of just one village's water catchment project.

In some cases it has been estimated that the initial investment was returned within six months of implementation, as a direct result of flood prevention outcomes related to torrential rains in the spring and summer of 2011. A double benefit was then also experienced, as the

retained water was gradually released into the landscape, dramatically reducing the impact of extreme drought that affected Slovakia in the second half of 2011. Crucially, these measures will continue to bring repeated benefits in the following years, particularly as the solutions begin to settle and new ecosystem niches are formed. Beyond the direct impacts to the local communities where these projects were implemented, it is estimated that the focus on municipalities in the upper watercourse sections has had a positive influence on 500 to 1 000 municipalities located in the lower river basins, because the measures have a beneficial influence on the reduction of flood and drought risks throughout the entire catchment.

Perhaps one of the most interesting aspects of the implementation of the program related to its almost entire focus on local community skills and resources. During its short 18 month lifespan, the program provided a total of 7,700 seasonal jobs for local people, and in the vast majority of cases utilised local natural materials such as soil, stone and wood. The positive impacts of this approach were twofold. Firstly, the public funds invested provided positive local community outcomes far beyond the direct impacts of the revitalisation measures themselves. Although only a small portion of the planned scope of the program was implemented, this Slovakian case study demonstrates a globally significant example of a fundamental solution in combating climate change, ecosystem degradation, flooding and drought risks.

Secondly, by engaging the local community in designing and building the solutions themselves, the community took on board ownership and stewardship of the solutions. This was made abundantly clear in the remarks and obvious pride shown by numerous community members I met during my participation with The Flow Partnership in a tour of the Slovakian countryside with the program's director, Michal Kravčík. What was clear from our tour of these projects was just how popular they have been within the local communities. While travelling the Slovakian countryside with Michal , he was often stopped as he walked down the street, often by people whom he had never met personally, people who simply wanted to thank him for the work he'd done in their communities.

But the response of Government has been a different story. Unfortunately, after only two years in power, the Government that had backed the Landscape Revitalisation Program lost power via a breakdown of their alliance. Upon gaining power, the current Slovakian Government immediately called a halt to the Program, even in the face of widespread support from communities and local governments throughout the country.

Jozef Matúš photo

Much needed employment under Revitalisation Program in Slovakia, resulted in check dams constructed in badly eroded gullies, using local, natural materials.

In seeking to understand why such a successful and widely supported program might be stopped dead in its tracks, the cynics amongst us might point to the sheer efficiency of the program as perhaps its greatest weakness. That is to say, in an area that, on the global scale is often associated with some of the largest levels of corruption known to man, the Landscape Revitalisation Program left almost no scope for corruption.

Whilst it could be argued that the above statement is largely

hearsay, one only needs to look at the Government's focus on previously dead "megadam" projects, to see where their agenda lies. But regardless, one thing is absolutely without doubt in my mind: The Slovakian Landscape Revitalisation and Integrated River Basin Management Program represents one of the single most important global case studies for a New Water Paradigm approach to water management, and as such, deserves global attention both in terms of the theories and philosophies that underpin the approach, but also in terms of the success achieved in empowering communities to create positive environmental solutions in their own interests.

Richard Widows photo

While on a tour of Slovakia's water restoration projects with Michal Kravčík, director, visitors observed a new forest area restored from a badly eroded area. The sign reads, translated in part: "The first implemented project site from a national program revitalizing the country and decreasing the risk of flooding in the municipality of Hhovec -2011."

For more information on the Slovakian Landscape Revitalisation and Integrated River Basin Management Program, I highly recommend this comprehensive book that was written on the subject, *After Us, the Desert and the Deluge*?, which is available at this link: http://www.ludiaavoda.sk/data/files/44_kravcik-after-us-the-desert-and-the-deluge.pdf.

Danka Kravčíková photo

A variety of styles of catchments were built under the Revitalisation Program in Slovakia.

Permaculture and Rainwater- the Essential Match

By Lauren Chase Rowell

Lauren Chase Rowell is current steward of Dalton's Pasture in Nottingham, New Hampshire (USA), and has been practicing and teaching ecological landscape design, installation, and maintenance for over 25 years. Her classroom instruction is informed by 35 years experience in regenerative food growing, medicinal herbs, and the importance of biodiversity in local, sustainable landscape settings. Lauren embraces the practical application of permaculture in earth-centered living and design, while simultaneously integrating the arts and contemplative practices into her teaching.

Permaculture, simply put, is the conscious design of everything humans do. Good design is critically needed at this juncture in our human story if we are to succeed as a species, and good design can be done by anyone. The blend of mindful intention, good old Yankee ingenuity, and common sense that constitute permaculture principles and practices, has made permaculture the mainstay of my lifestyle for many years at my family farm, Dalton's Pasture.

Permaculture stresses the importance of diversity more than any other interdisciplinary practice or study. It kicks ecology up a notch as it blends the complexities of human needs and human nature with natural systems. Water plays a primary role in blending natural and human-designed diversity. One of the most important decisions we made early on, as a result of keen observation of our land, was to build a small dam in a seasonal trickle of water that wound through a narrow, red maple swamp. After studying the channel of the rivulet, we found the logical place to block it and built a wooden structure

Jan Lambert photo

Drinking water for chickens is collected via a rainwater collection barrel.

about twenty-four inches high. The center of the wetland we created is now a sea of green cattails. The root tuber, the bottom few inches of the inner stalk, the pollen, and the young seed structure of the cattail are edible, so we see the cattails as part of the food system.

The lesson we learned: if you want to revitalize the place you've chosen to put down your roots, bring in a diversity of living things and to accomplish that in the fastest possible way, make water available. Do that by first studying and understanding your watershed, from the large one in your region to the little ones crossing your property. Then, capture, store and use the water to bring in life!

For twenty-five years we have continued to add water to our landscape. Water seems to beget more water as it attracts moisture to itself. The area we created long ago has become a vibrant wetland, feeding the narrow, mostly dry channel that wound and disappeared over and under our land. Over time, the water we captured helped develop a series of wet habitats through forested wetland, open pasture, shrub lands, and our landscaped yard.

Dense plantings increase habitat and biodiversity. One doesn't have to build a wetland of the proportions we did in order to kick-start the building of life in a landscape. Any water will do. We decided that an outdoor shower would not only be convenient, but also put the much-needed water directly onto the landscape. Then we added six full-sized wooden whiskey barrels that collect rainwater and are strategically placed where we can use them. Rainwater is used to water container plants, transplants, propagation seedlings, and even chickens! Tree frogs often take up residence in the barrels, their beautiful skin blending in with the silver wood, and pickerel frogs and bullfrogs call the little pools we create their home.

Jan Lambert photo

One of six re-purposed whisky barrels at Dalton's Pasture serves as a picturesque rain barrel for watering a vegetable garden.

Peter Rowell photo

This pool is not just attractive; it functions as a rainwater retention and filtering site.

Where rainwater collection isn't enough of a solution in sheet drainage areas such as large roofs, we have constructed two "water features." The first one collects an abundance of roof runoff. When it overflows, it fills up the surround-

Jan Lambert photo
Cattail wetland featuring a walkway was created by small water catchment at Dalton's Pasture.

ing area which was dug down to an eighteen-inch depth, fitted with a piece of recycled rubber roofing, and refilled by mixing forest leaf mold and compost into the gravelly soil taken out of the hole. A bog garden now thrives there, allowing specialist niches for biodiversity in a place that used to be a gravel-desert. It seconds as a place to scoop out water for houseplants, to water thirsty dogs, and to cool and humidify the microclimate. This landscape with a water garden provides stacking functions: habitat, water catchment, increased humidity and cooling, sediment settlement and filtration, soil improvement, and a sense of calm beauty. As visitors approach they are greeted by the tinkling of water, a lush oasis of greenery with a full complement of frogs, newts, and tiny quarter-sized turtles, and a cool, refreshing welcome. A solar-powered fountain also stacks functions by aerating the water and attracting wildlife with its wet splashing noise.

The second water feature is on the lowest part of a gradual slope. The slope was graded to move water away from the antique buildings while spreading the flow over a wide area. Water is then intercepted into a densely planted polyculture. Any excess run-off not infiltrated on its journey across the landscape, ends up in the water feature. Here, any sediments and organic nutrients have a chance to settle out, where they become the substrate and food resource for the native pond lilies, cardinal flowers, and floating duck weed. Again, through stacking functions, this consciously designed system serves many purposes. It provides a habitat for animals and serves as a sediment catchment for water that will eventually end up in the wetland system and it waters thirsty insects, wildlife, and our dogs. Dense vegetation and stepping stones protect

Jan Lambert photo
Wildlife, such as this Pickerel Frog at Dalton's Pasture, abounds in a water-abundant permaculture landscape.

the soil and prevent compaction. Stepping stones keep people on the path to reduce soil compaction, and leaf litter is left on. The dense layers of structural vegetation further protect the soil from pelting rain, northwest winds, and the high-noon sun.

All of these successes have been dependent primarily on water moving through our landscape as part of the natural water cycle. Little to nothing would have grown if we had not captured and stored water in wetlands, swales, and in the soil column, as well as in water-feature-ponds and rain barrels. Water is truly synonymous with Life!

For more information search "Lauren Chase Rowell permaculture" on the internet.

The New Water Paradigm and Carbon Farming

By Jan Lambert

There is growing recognition that the biosphere—Earth governed by life—is the chief ruling force of climate, and that letting the biosphere heal itself will in turn heal the climate and provide abundance for humanity as well. In particular, the role of carbon in soil health, and the role of healthy, living soils as the answer to sequestering excess CO2 from the atmosphere, via "carbon farming," is being actively researched and practiced worldwide. By increasing organic matter and vegetative cover, and altering the grazing patterns of livestock, farmers, ranchers, foresters and gardeners are building both fertility and the water-holding capacity of the land.

Jan Lambert photo
Domestic cattle, if properly grazed, can improve water retention of the land.

Perhaps the most monumental and stunning revelations have come through the work of Allan Savory, who developed the livestock management strategy termed holistic grazing. He has studied how wild herbivores typically graze tightly bunched together, for protection from predators; they graze everything down in one area and then move to a new area of fresh forage. Instead of letting cattle or sheep roam over one or a few large pastures all season, holistic ranchers confine the animals in a small areas with electric fencing, and then moving them frequently to fresh pasture. The results have been astounding; the health of the land and the animals improves, and the ranchers are able to run more cattle on the same amount of land and improve their income.

Although Allan Savory's ideas about livestock grazing have met with some skepticism and even hostility from academics and researchers, farmers and ranchers are reporting astounding results on their land. For example, the veteran ranchers featured in the following video, a quick and entertaining introduction to holistic ranching, "Soil Carbon Cowboys" at https://vimeo.com/80518559.

And from the standpoint of rainwater retention, there is no argument that increased organic content, which contains carbon, in soil means increased water holding ability. Seth Itzkan, who has visited Savory's Africa Center in Holistic Management (ACHM) in Zimbabwe,

reports that holistic grazing management is being practiced in part, "because as the land gets better (more grass cover), farmers not only have more forage for animals, but they also have more plentiful wells and streams. This is a matter of life and death."

There are two books from Chelsea Green Publishing about soil carbon and water restoration, which I heartily recommend as very entertaining reading with on-the -ground stories of carbon farming success. The first is *Grass, Soil, Hope* by Courtney White. In the chapter, "Healing the Carbon cycle With Cattle," White writes about Tom and Mimi's JX Ranch in New Mexico (USA), that after switching to holistic grazing, "the water cycle has improved all over the ranch, a consequence of water infiltrating down into the grass-covered soil, rather than sheeting off erosively as it had before."

And in her book, *Cows Save the Planet*, Judith Schwartz delves extensively into soil carbon-building and its healing influence on the water cycle. Rather than assuming that we are inevitable victims of water disasters, she writes, "Allan Savory's belief that drought and floods are man-made and therefore not inevitable opens the way for a different response." With holistic management, grazing lands can retain more water, absorbing heavy rainfall and retaining the water for drier periods.

It is time to accept the complexities of climate and ecosystems, when considering causes. The good news, however, is that there is nothing standing between the soil carbon viewpoint and the New Water Paradigm, as far as the actions needed. Any action to restore soil with carbon will restore water as well; they are inextricably linked.

Seth Itzkan photo

New surface water year-round on a river in Zimbabwe. For more information click on http://www.planet-tech.com/blog/holistic-management-and-water-restoration.

Swales Harvest Water at Greg Judy's Farm in Missouri (USA)

By Jan Lambert

Water is vital for farming, and a central part of Greg Judy's holistic management is harvesting rainwater in the land. "By capturing every drop of water and holding it on our farms," said Greg, "we can grow more forage and food." One of Greg's newest projects is a series of swales (shallow depressions) he has installed in fields to retain rainwater and snowmelt. The captured water will provide the moisture needed for a wide array of food-producing plants that Greg is putting into the back base of the swales. The list includes mulberry, persimmon, chestnut, pecan, walnut, oak, hickory, apple, peach, and cherry trees; grapes, raspberries, blackberries, strawberries and various vegetables.

Used for watering Greg's cattle, the swales are protected from trampling by electric fencing. In less than a year after Greg dug his swales, he reports, "We have ten swale ponds that never go dry, and they are attracting a lot of wildlife as well. The frogs and tadpoles are just unbelievable!"

Greg's farm is a wonderful example of how harvesting rainwater benefits the land, its wildlife, agriculture and human needs, quickly and simultaneously. Find out more at Greg's website at www.greenpasturesfarm.net/.

Greg Judy photo

Greg Judy's healthy cattle are 100% grass fed, and moved frequently to fresh pasture, a holistic technique that builds up soil fertility and moisture.

Greg Judy photo.

A water-filled swale on Greg Judy's farm ensures a vital component, water, to the farm's productivity.

Bringing Back Water, Bringing Back Wildlife

Contributed by Cuenca Los Ojos Foundation

The Cuenca Los Ojos ("Watershed of Springs") Foundation is dedicated towards improved understanding and appreciation at local, regional and international levels of the biological diversity along the United States-Mexico boundary. Cuenca los Ojos (CLO) is a leader in adapting to climate change. In a part of the world that has been drying up, CLO is reversing this trend by restoring habitat through an ancient tradition of slowing erosion and harvesting water -- water that would otherwise would rush over a desiccated landscape.

Trincheras are small check dams that slow the water down, allowing it to percolate into the soil, and release more slowly over time, thus preventing all the water from simply rushing away in storm event, and allowing the ground to act as a giant sponge, holding water and releasing it slowly over time. Gabions are similar in function, but the rocks are actually contained within a wire basket built across the stream channel. Gabions are generally used in larger, more powerful stream systems, and trincheras are generally used in smaller tributaries. Both create small temporary ponds after substantial rains. Bringing water back to the land has resulted in remarkable vegetation changes, which in turn has increased populations across the wildlife spectrum.

CLO photo

Trincheras (check dams) on Turkey Creek.

CLO photo

Restoration of water is a high priority of the Cuenca Los Ojos Foundation working on the USA/Mexico border.

The rugged landscape, consisting of mountains and valleys running north/south along the US-Mexico border, provides rich habitat for many native and migratory species. Cuenca los Ojos has worked with the federal and state governments of Mexico to secure permanent protection of these lands and the animals found there. The first step was to protect a vast region of open space. The second step is to manage the forested mountainsides, valleys, canyons, wetlands and riparian (streamside) zones for the benefit of plant and animal species. CLO uses science-based methods of restoring the land and water resources these species need to survive. The third step is to work with partners to establish a vast interconnected network of protected lands to facilitate the movement of wildlife.

"Restore the habitat and the animals will come" is one of CLO co-founder Valer Austin's mantras. In the riparian areas that have been restored, countless songbirds, raptors, waterfowl and aquatic species are plentiful. With funding

CLO photo

Yellow-Billed Cuckoo.

CLO photo

Ocelots are occasionally sighted in the CLO restored areas.

Jan Schipper photo

A Coues Whitetail Deer and a Gould's Turkey share a CLO watering spot.

from the US and Mexico, CLO is successfully enhancing degraded habitat for many threatened and endangered species, such as Yellow-billed Cuckoo. CLO is also reversing a hummingbird decline by restoring the water table and riparian areas, as well as planting wetland pollinator vegetation. Hummingbird populations provide valuable information about the health of the habitat; therefore CLO uses hummingbirds as indicator species to evaluate which areas need to be restored and the effectiveness of restoration techniques.

Once plentiful in the valley of between the US and Mexico, the native populations of Coues deer all but disappeared from over hunting. Under CLO's management, hunting has been suspended and CLO has increased the existing population with two reintroductions, and is enhancing the habitat they need with water catchment systems that provide water in the dry months and by providing supplemental feeding when adequate forage is not available due to fire or drought.

Many species benefit from these habitat enhancements: the populations of turkey, bear, and mountain lions are increasing. The occasional appearance of rare species such as jaguar and ocelot are signs that some southern species are beginning to move north. As this happens, CLO believes that it becomes increasingly important to create a secure network of protected lands to accommodate movement pattern.

References

The following two references provide scientific basis for the value of check dams and gabions in improving the hydrologic functions of the lands restored by CLO. For more information visit the CLO website at http://cuencalosojos.org/

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Jan Schipper photo

A Black Bear enjoys a dip in a CLO restored watering hole provided by rainwater retained behind a trinchera, or small check dam.

The Memory of Rain- A Message From Vermont (USA)

By Justin Kenney

Close your eyes and take a long, deep breath. Think back to your childhood. Remember those hot summer days basking in the sun, the sudden downpours and hunkering down beneath the boughs of a large tree. The rain disappearing in the canopy above, while you stayed dry. The land soaking up the storm.

Now think back to a recent trip to the store in town when the rain came down in buckets, your mad dash to the car with puddles giving way under feet. The rhythmic sway of wiper blades while you witness the rainwater turning brown and dirty, parting like the Red Sea as you make your way home. Rivers running near capacity. The uncertainty of what that means. Take a moment to reflect about those two memories and the subtle but very important differences between them.

In the first, there is a special hydrologic magic at work. Through a process called interception, the leaves of the tree are physically stopping a portion of the rain from getting through the canopy, creating a somewhat dry environment below. What does get through is quickly absorbed into the soil below, recharging the groundwater table and slowly feeding local streams. Even after the rain stops, the tree continues to work its magic by pulling water up through its roots and trunk, and then transpiring it out through its leaves, all the while absorbing nutrients and creating capacity within the soil to absorb the next storm.

In the second, the nature's hydrologic magic is replaced by something much more sinister, engineering voodoo. Instead of trees and other biological systems, impervious surfaces, catch basins and pipes dominate the landscape. Nearly 100% of the rainfall reaches the land surface and is captured, piped and directly conveyed to nearby waters. The result? Increased volumes of water flowing across the land surface, decreased groundwater levels, in-stream erosion, polluted waterways, and a heightened risk of flooding.

I wanted you to relive these two memories to understand that hydrology (which is actually quite far from magical) is important and has far-reaching implications on our economy, environment, and society. Stormwater runoff from impervious surfaces is one of the leading causes of water quality impairment in Vermont and throughout the nation and is primarily a result of land use change and development. The farther we get from the natural condition of a site, the worse the problem gets.

Luckily, we have some tools in at our disposal. We can adopt low impact development (LID) bylaws and regulations that avoid and minimize the impacts to natural hydrology by protecting natural systems like wetlands and reducing impervious coverage and clearing. We can implement green stormwater infrastructure (GSI) that mimics nature to filter, treat and store excess water. Such practices include green roofs, rain gardens, pervious pavements, rain barrels, and constructed wetlands.

We can also utilize stormwater master planning to identify the places on the landscape where those practices will provide us with the greatest benefit. All of these things bring us one step closer to a sustainable stormwater management regime that balances our need for a clean and healthy environment and the use and enjoyment of the land.

Ready to open your eyes? Check out the Vermont Department of Environmental Conservation's green infrastructure web site to get started! Go to http://www.vtwaterquality.org/stormwater/htm/sw_green_infrastructure.htm.

Photos courtesy of Vermont Green Stormwater Infrastructure Program

Traditional stormwater management (above) is increasingly being replaced by approaches more in tune with natural hydrology (below).

From Grey to Green - Evolving Better Responses For When It Rains In the City

By Jan Lambert and Pete Hanrahan, Erosion Control Manager, E. J. Prescott, Inc.

When the well is dry, we learn the worth of water.
- Benjamin Franklin

For years abuse of our environment has been rampant. Factories have been built along rivers and streams, using water not just for power and production, but also for waste disposal. Adjacent property is routinely negatively impacted by construction activity, but this is a consequence of growth that has always been for granted. Until relatively recently, there have been few concerns raised about increased flow volumes from newly developed areas.

Rachel Carson published her landmark book, *Silent Spring*, in 1962, and this publication brought widespread attention to the environmental movement. Loudly and firmly, she proclaimed, "In an age when man has forgotten his origins and is blind even to his most essential needs for survival, water along with other resources is a victim of his indifference."

In urban areas the storm drain and the stormwater sewer system has been typically taken for granted as the efficient way to manage rainfall. This way of dealing with water needs to be changed, however, and we all need to sit up and take notice, that we must stop treating rain as a waste product and instead work with nature to save rainwater in urban soil, plants and catchments. As presented with the New Water Paradigm, rainwater is no longer to be considered an inconvenience, but a major asset wherever it falls.

The benefits are enormous. By not sending so much water directly into rivers, it is obvious that we can reduce flooding, which is of major concern to anyone living near a river. Vegetated areas also will help filter out pollutants in urban stormwater, and cut down on the loads of sediment (soil particles) that currently clog our streams. (Sediment, in fact is the number one pollutant carried by water.) At the same time, river levels can be kept at more constant and moderate levels, as water percolates slowly through the ground, and the replenishment of water tables and reservoirs needed for drinking and other uses, can be increased.

Jan Lambert photo
Parking lots not only direct all the runoff into storm drains; they also generate significant amounts of heat into the local and regional atmosphere.

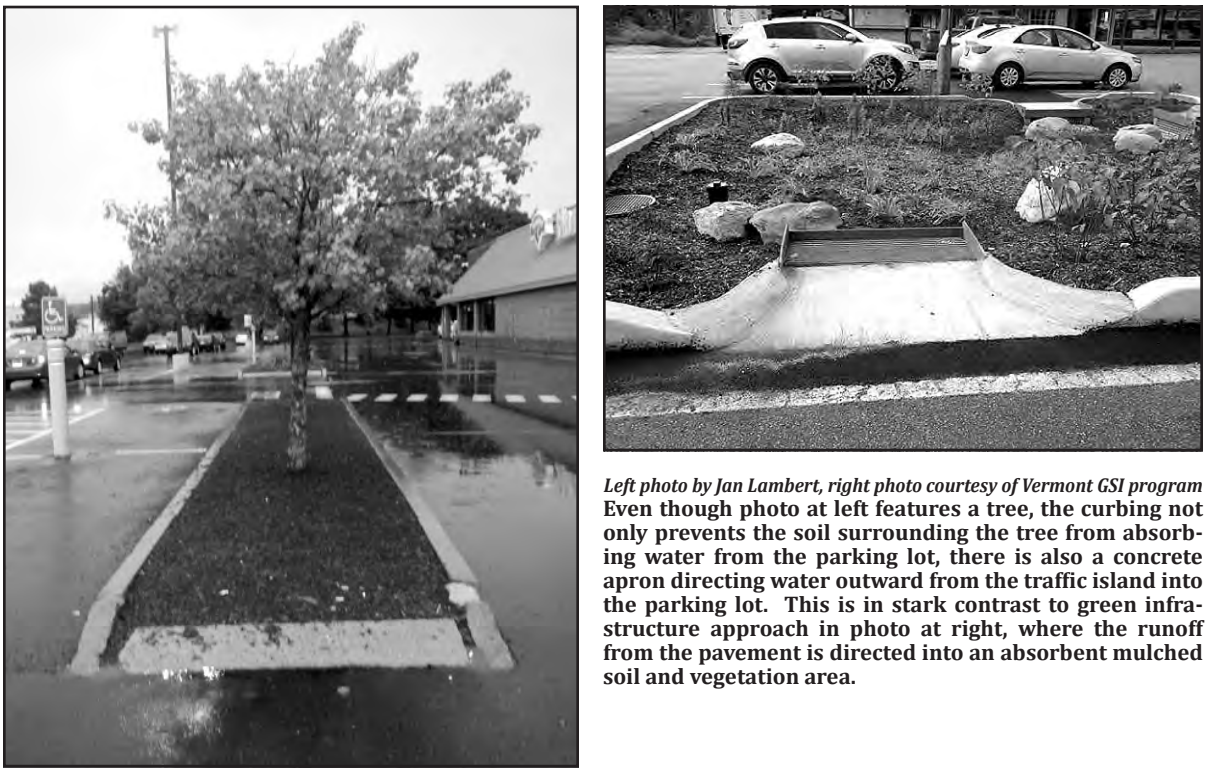
In 1967 Ian McHarg published his classic work, *Design with Nature*. McHarg's book, far ahead of its time, would lay the foundation for the Low Impact Develop-

GREY TO GREEN INFRASTRUCTURE-MAKING THE SWITCH

Jan Lambert photo

Typical, familiar "grey" approach to stormwater is to channel it quickly into storm drains, along with pollution from the street, and into the nearest stream via stormwater pipes.

ment (LID) movement some two decades later. LID is the design approach that maintains the natural hydrology of the area to be developed. LID, along with Green Stormwater Infrastructure (GSI), is becoming an increasingly common term nowadays for the management of water in de-



Left photo by Jan Lambert, right photo courtesy of Vermont GSI program

Even though photo at left features a tree, the curbing not only prevents the soil surrounding the tree from absorbing water from the parking lot, there is also a concrete apron directing water outward from the traffic island into the parking lot. This is in stark contrast to green infrastructure approach in photo at right, where the runoff from the pavement is directed into an absorbent mulched soil and vegetation area.

Jan Lambert photo

Conventional storm drain on street at left is the standard with grey infrastructure, whereas the green infrastructure approach utilizes a street side rain garden, which utilizes a curb drain that directs runoff to an area of attractive plantings. Both photos were taken in Keene NH (USA).

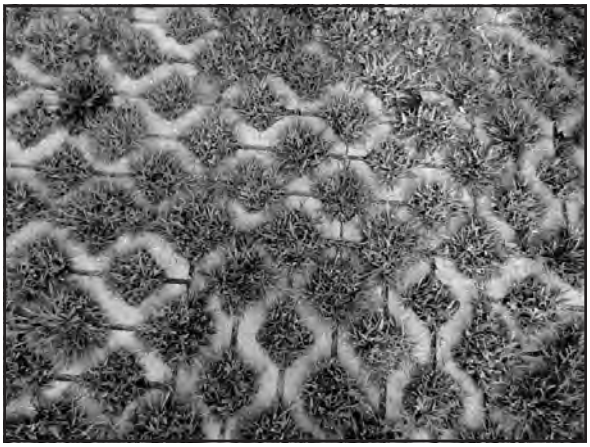
veloped areas. GSI is an approach that seeks to follow nature by using rainwater infiltration and vegetation to restore natural water cycles. This is in contrast to "grey" infrastructure, the conventional system of roofs, downspouts, pavement and drain pipes.

Urban areas can improve both their own climates and in the greater region, with GSI water management. Paved areas and roofs not only increase water runoff, they also heat up quickly in the sun much more than a area with plants, which absorb the sun's rays and convert the solar energy into water vapor instead of heat. By interspersing paved areas with more vegetated areas that are constructed to infiltrate rainwater, the excessive heat can be moderated. More trees can also mean more shade for the pavement. "Green" roofs, covered with plants, absorb stormwater and cut down on heat generated. And of course plants provide beauty, and people are naturally attracted to urban areas with plenty of vegetation.

In a touching anecdote in *Design With Nature*, Ian McHarg describes a conversation between an native American and his son, centuries ago. When the son asks his father whether or not he will inherit an environment undamaged and unharmed by his generation, that father is able to answer in the affirmative. Sadly, when this book was published in 1967, a modern American dad would have had to answer no. Now, some 45 years later we can be proud that we have made some progress toward this goal, but there is much more work to be done.

Photo courtesy of Vermont GSI program

Roof planted with hardy vegetation in Vermont (USA) absorbs rainwater and also helps to cool the atmosphere.



Jan Lambert photo

Green infrastructure approach includes grass and concrete water-permeable alternative to pavement, in a driveway to a cemetery in Keene, New Hampshire (USA).

Glasgow, Scotland: A World Class Green Roof

Information provided by Filtrexx®

Green roofs help to increase rainwater retention and reduce the heat island effect within cities, as well as increasing the absorption of CO2. At the same time green roofs improve a building's thermal performance, and reduce the long-range costs of a roof by protecting it from weathering and ultraviolet light.

The SSE Hydro, Scotland's national arena, is the latest landmark on the Glasgow skyline. This 12 000 seat arena designed by the London-based architects Foster & Partners, officially opened on September 30, 2013. The SSE Hydro hosts international musical stars and global entertainment and sports events, and is expected to attract one million visitors each year, which would make it the fifth-busiest entertainment venue worldwide, and position the SSE Hydro among the world's most prestigious venues, along with Madison Square Garden and London's O2 Arena.

Therefore many visitors may be there and be impressed that the SSE Hydro includes a massive green roof that encircles most of the arena. The roof pitch varies from 8° to 52° and its height that ranges from 8 to25 meters above ground level. The installer, Scotbark of Glasgow, used Filtrexx® GroSoxx®, special flexible hollow filtration tubes filled with a growing medium, using blower trucks outfitted with 120 meter hoses. More than eleven miles of soil-filled GroSoxx were placed on the roof and then planted with 37 000 *Lonicera nitida shrubs,* evergreen plants native to China, in the 1200 cubic meters of growing medium. Thus soil loss and wind damage were much reduced using this method.

Photo courtesy of Scotbark

Green roof being installed at SSE Hydro Arena.

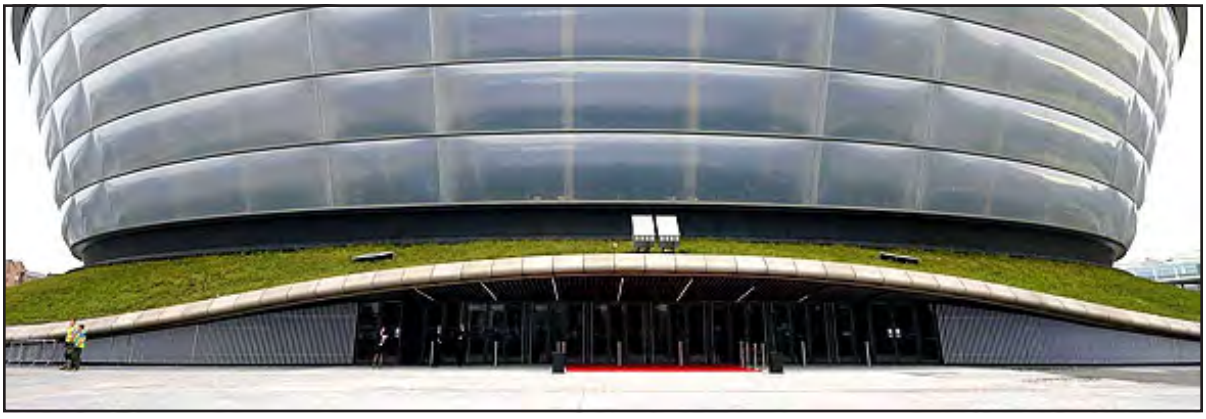
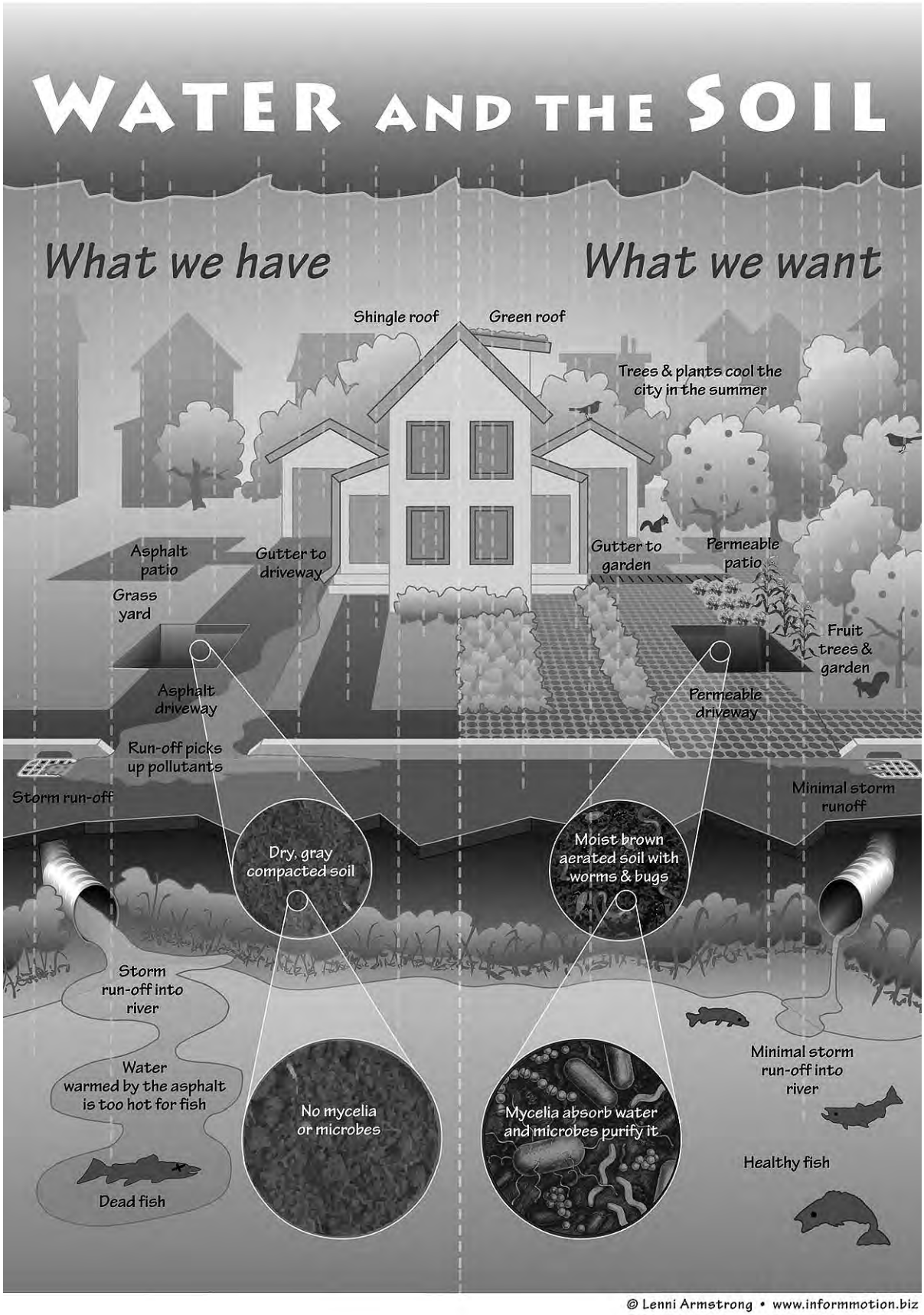


Photo courtesy of Scotbark

A green roof at SSE Hydro, Scotland's national arena in Glasgow, is planted with 37 000 shrubs.


WATER AND THE SOIL
What we have
What we want
Shingle roof
Green roof
Trees & plants cool the city in the summer
Asphalt patio
Gutter to driveway
Grass yard
Gutter to garden
Permeable patio
Fruit trees & garden
Asphalt driveway
Permeable driveway
Run-off picks up pollutants
Storm run-off
Minimal storm runoff
Dry, gray compacted soil
Moist brown aerated soil with worms & bugs
Storm run-off into river
Water warmed by the asphalt is too hot for fish
Dead fish
No mycelia or microbes
Mycelia absorb water and microbes purify it
Minimal storm run-off into river
Healthy fish
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Hosting a "Depaving" Party!

By Lenni Armstrong

According to the City of Somerville, Massachusetts (USA) where I live, 77% of our land is impervious surface– pavement and rooftops. We actually have entire backyards paved over! Realizing that pavement prevents rainwater from soaking into the ground, we decided to do something about it.

Vanessa Rule of Somerville Climate Action got our first Depaving Party going in 2010, and Cador Price Jones and I organized a second one in 2011. Since then, Cador and I have organized two depaving parties each year. Cador works for a construction company and supplies the tools: sledgehammers, pry bars, and wood blocks for leverage. A local business generously donated hard hats, goggles and work gloves.

One of the paving parties transformed the property of Steve Langdon and Laurie Gray. Here is how they describe it:

We had our depaving done around two years ago. It's made a huge difference to the way we use our backyard. After the depaving, we installed raised beds for vegetables and herbs and have had some good crops. Rather than plant a lawn, we have used pea gravel for the areas around the raised beds and as a design element. We enjoy sitting in the garden and looking at it from our back porch. What was a large area of asphalt is now a green oasis in the middle of the city. We have recently sold the lower unit of our house, and everyone who looked at it was hugely impressed by the garden! I know it was an important selling point.

Mike Beach photo

VICTORY! The depaving party celebrates success after removing pavement from the yard of Steve Langdon and Laurie Gray in Somerville, Massachusetts (USA).

We sold our apartment in four days, and had 24 offers; and in the "love letters" that we received along with many of the offers, the garden was always mentioned as a big factor. The people who eventually bought the apartment are avid gardeners and the organic raised beds were a big part of what they loved about our house.

Listen to Lenni Armstrong's TedXSomerville talk on depaving at https://www.youtube.com/watch?v=BlTG0Y_zknc.

Lenni Armstrong photos

A group of citizens in Somerville, Massachusetts (USA) gathered at a "depaving" party to transform this paved urban backyard unto an oasis of productive gardens with a pea stone path, which allows rainwater to percolate into the ground, and also cuts down on the urban "heat island" effect. It also significantly increased the property's value.

Vermont (USA) Watershed Groups to the Rescue!

By Ann Ingerson

Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.
- Margaret Meade

Vermont's community-based watershed groups have worked hard to improve watershed health over several decades. Now they need your help. Intense storms have become more common in recent years, including tropical storm Irene which brought us graphic images of flood damage, and we expect more extreme floods in future years.

Why is grassroots action so important to address Vermont's water pollution and flooding problems? As a rural state, Vermont has few direct discharges from factories or waste treatment plants where we can use "end-of-pipe" treatments to filter out pollutants. Instead, most of our water pollution comes from runoff across the landscape. Polluted runoff flows from eroding dirt roads and ditches, slumping stream banks that lack natural wooded buffers, corn fields left bare of cover before planting or after harvest, poorly-sited woods roads or stream crossings, or dirty urban pavement draining directly into nearby streams. See the pattern?

Reducing these "non-point" pollution sources is much more complicated than upgrading an urban waste treatment plant or filtering an industrial outlet pipe. Solutions include rain barrels and rain gardens that retain rainfall on suburban properties; no-till, cover crops, manure injection, and vegetated stream buffers on farms; dirt roads that resist washouts to keep sediment out of streams; water bars and portable skidder bridges for logging operations; and diverse other measures that reduce or filter runoff one small step at a time. Many of these measures have the added benefit of reducing flood damage by slowing runoff or giving rivers space to move as they like to do.

Jan Lambert photo
Major source of pollution and flooding: Stormwater from pavement is often flushed rapidly into rivers via storm drains.

Unfortunately, solutions rarely involve quick fixes and it's not always easy to sustain attention - and investment - over the long haul. Yet sustained effort is what it will take to help our waterways regain health and become more resilient to severe storms.

Big environmental problems like these can seem overwhelming. Joining a team of dedicated like-minded can-do volunteers is a great antidote to despair. Many hands make light work, and improving watershed health certainly requires many hands. Volunteers are needed to plant

Jan Lambert photo

Local watershed groups can work to help protect valuable wetlands that help store rainwater and filter runoff, but natural areas need to be protected from pollution.

Jan Lambert photo

Citizen involvement in watershed groups can often address storm runoff from a widespread area often causing eroded gullies in forested areas, such as this slope adjacent to a lake.

stream side trees and rain gardens; educate school children and shoreline landowners; sample water quality in streams; inventory storm drains; haul trash out of rivers; develop websites and newsletters and Facebook pages to involve and inform more people; raise funds and do mailings to support and expand this important work.

Whatever your particular talents and interests, your local watershed group has a job for you. For more information check out www.watershedsunitedvt.org.

BUILD A RAIN BARREL TO HARVEST YOUR RAINWATER!

Photos courtesy of Black River Action team

Vermonter Larry Kasden puts finishing touches on rain barrels constructed by volunteers of a watershed group, the Black River Action team, in Springfield VT (USA). The finished barrel pictured at right is one that local resident Herb Jameson built at a community workshop and modified at home. Rain barrels are used by homeowners, schools, etc. to collect rainwater from downspouts; the water is prevented from entering storm drains and is useful for watering plants, thus saving tap water. Information is readily available online.

We Are All That "Somebody"!

By Kelly Stettner,
Director of Black River Action Team
Springfield, Vermont (USA)

"You're 'somebody'!" Those infamous words kick-started Kelly Stettner's grassroots efforts at cleaning up the Black River, Springfield VT (USA) in the fall of 2000, and she's been going strong ever since. With a strong focus on water quality, citizen science, and home-grown elbow grease, Stettner has cultivated scores of volunteers to form the project-based Black River Action Team (BRAT).

Rain 'n' snow 'n' where it all goes... precipitation is the key to keeping our wells full, our rivers healthy, and our gardens and lawns flourishing. When rain and snowmelt soak into the ground, it's a good thing. When that water does NOT slow down, spread out, or soak in, it can cause big problems. Storm runoff — that's rain and snowmelt that does not recharge the groundwater but instead "runs off" roofs, driveways, roads, and other impenetrable surfaces — has caused some serious damage and problems in Pedden Acres, a little neighborhood nestled up on a natural terrace left by a prehis-

Jan Lambert photo

HELP IS ON THE WAY! Meg Stern is dwarfed by the size of the chasm in her back yard, which has been the result of years of stormwater runoff in her neighborhood in Springfield, Vermont (USA). Grassroots community action has been instrumental in working with official and volunteers to come up with a solution that will include green stormwater infrastructure, which uses vegetation to capture storm runoff.

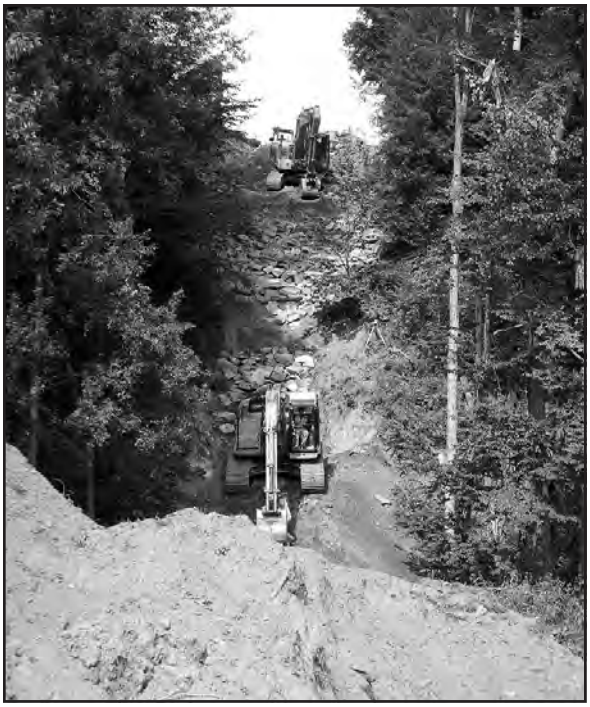
toric ancient lake, in Springfield, Vermont.

When it rains, it pours... and Meg Stern loses more of her backyard with every storm. Her property dates back to the 1960s, when no effective plan was designed for the management of rain water or snowmelt running off every roof and driveway. Water pools up on the road, collects at a low point in front of Meg Stern's home on Meadow Drive, and begins to run as a small stream along the fence line between her yard and her next-door neighbor's. The water races down a slope to the back edge of her yard and eats away at the sandy soil there; it's been a growing problem in the ten years Meg has lived there.

In late August of 2011, Tropical Storm Irene dumped many inches of water on Vermont in an utter deluge, and what had been known as the "little gully" became a gaping chasm twenty feet wide and thirty feet long. Meg reached out to Black River Action Team Director Kelly Stettner, in hopes that some practical solution could be discovered.

The chasm is within a few feet of the edge of Meg's leach field; clearly something must be done, before the erosion endangers the foundation of her home or her neighbor's. Property values are at stake, as is the water quality of nearby Carley Brook and the Black River. It has taken some effort, time, and persistence, but a wonderful collaborative effort is now underway to solve not just Meg's problem but to address the larger issue of managing storm runoff on Meadow Drive.

The Town of Springfield has received a grant to have a contractor install a storm drain system along the road, and to rebuild Meg's backyard from the bottom up. In partnership with the Ottauquechee Natural Resources Conservation District and SWALE of the Valley Green Journal, BRAT is taking point on the grassroots level: hosting stormwater "expos" to present a variety of tools and programs available to help manage rain and snow-melt; reaching out to the community at large to offer information on the effects storm runoff has on water quality and property value; and working with Meadow Drive residents on an individual basis to address stormwater management on their properties. From diverting their downspouts to a drainage easement to installing rain barrels or rain gardens, there are a number of simple and inexpensive techniques to "slow it down, spread it out, soak it in" – the mantra of those in the world of storm water runoff!



Photos by Jan Lambert

LEFT: Start of the Pedden Acres project, Sept. 2015. RIGHT: Kelly Stettner, Director of Black River Action Team surveys the gaping chasm that threatens Pedden Acres.

Your Land, Your Water, Your Solution!

Soak Up the Rain New Hampshire (SOAK NH) is the newest outreach and assistance program of the NH (USA) Department of Environmental Services (DES), with the goal of protecting and restoring clean water in the state's lakes, streams and coastal waters from the negative impacts of stormwater runoff. SOAK NH provides resources for homeowners and small businesses to install rain gardens, rain barrels and other stormwater practices to reduce runoff and pollution.

Stormwater runoff is rainfall or melting snow flowing across our landscapes that has not soaked into the ground. In forests, meadows or other natural areas, rainwater soaks into and naturally filters the soil. When forests and meadows are developed, however, they are replaced with neighborhoods, shopping centers and other areas that introduce impervious surfaces such as roofs, roads, parking lots and driveways, which prevent rain or melting snow from soaking into the ground. This creates excess stormwater runoff and pollution, flooding, and erosion.

Since SOAK NH first got started in 2013, the program and its partners have soaked up an estimated 151 000 gallons of runoff and have prevented over 11 000 pounds of sediment, more than 3 pounds of phosphorus, and almost 7 pounds of nitrogen from polluting water bodies across the state. By installing a stormwater practice such as a rain barrel or rain garden, you'll be helping the rainfall on your property restore the natural water cycle, preventing floods, reducing pollutants such as pet waste and excess lawn chemicals from washing into nearby lakes and streams, and recharging groundwater.

Soak up the rain NH

Step-by-step instructions for building nine different stormwater practices are described in the New Hampshire Homeowner's Guide to Stormwater Management from DES. You can find this publication and much more information online by visiting the SOAK NH website at www.soaknh.org.

RAIN GARDEN INSTALLATION AT CAMP MORGAN, WASHINGTON, NH
Citizens Install a Rain Garden

Information provided by New Hampshire's Soak Up the Rain program

Note: A rain garden is a bowl-shaped area with plantings that absorb rainwater, typically collected from a downspout or paved area; the purpose is to reduce the stormwater entering storm drains and thus reduce flooding and drought, to filter out pollutants, and to be esthetically pleasing.

The Camp Morgan Lodge in Washington, New Hampshire (USA) sits atop a hill overlooking scenic Millen Pond, where a rain garden now adds to the scenery. The lodge is widely used as a community gathering spot and is the perfect setting for the rain garden as an outreach tool. Visiting community members will see how rain gardens can harness water that runs off of the roof and envision how a similar garden could work on their own properties.

Jed Schwartz, Chairman of the Washington Conservation Commission, contacted the Soak Up the Rain (SOAK) team of the New Hampshire

Department of Environmental Conservation, to see if the program could reach into his community. Jed and his team walked the camp property to look for opportunities, and decided that a rain garden at the Camp Morgan Lodge would be the best way to educate the community and to spread the word about the SOAK program.

On a gorgeous August day, the SOAK team started the morning off with a short presentation to Millen Pond Association members on why stormwater runoff is a problem, how the program advises addressing it, and how the rain garden installation would help to protect the pond. Later in the morning, work began to excavate the 45 foot long rain garden. Before long, day campers of all ages and their counselors came in groups to help dig and build the rain garden. At one point there were so many campers helping out that there weren't enough shovels to go around! After lunch, the crew completed the gardens with plantings and mulch.

Thanks to the hard work of Jed, community volunteers, and the campers and counselors of Camp Morgan, the Washington rain garden will serve as an attractive ambassador for continued

SOAK projects in the Millen Pond watershed. It will also help protect the water quality of Millen Pond by soaking up an estimated 4,185 cubic feet of runoff, 5.58 pounds of sediment, 0.02 pounds of phosphorus, and 0.32 pounds of nitrogen each year.

To learn how to build your own rain garden or to find out about other ways to manage stormwater on your property, explore the Soak Up the Rain NH website at www.soaknh.org.

Photos courtesy of Washington Conservation Commission
Citizens of Washington, New Hampshire (USA) pitched in to install a rain garden at a community center that is directly adjacent to a lake. Storm runoff to the lake has been reduced and the building has also been made more attractive.

Reflections

By Jan Lambert

He leadeth me beside the still waters.
Psalm 23:2

Jan Lambert photo

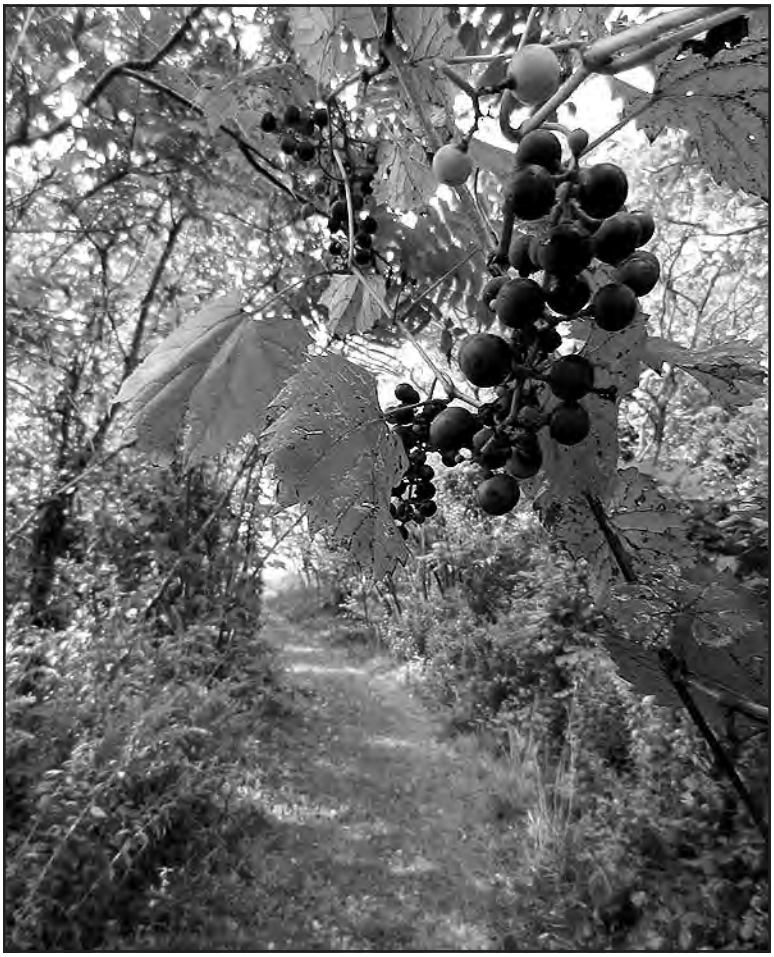
Willard Pond, New Hampshire (USA).

...After spending countless hours in the last year researching, networking, and especially experiencing the critical connections in water, land, and climate, I am changed. Water is no longer just a substance I take for granted, it has risen to the top of my consciousness. But water is also central to our cultures, our language, and our spiritual lives. If as people re-connected to our roots in Nature, we could collectively connect with miraculous water, it could become a great global unifier and source of peace, through the grassroots action of ordinary people. By joining with fellow kindred spirits who seek to unite globally for the restoration of natural water cycles for the survival and betterment of the humanity and all life, I have discovered a cross-cultural global community. Caring people are everywhere! Personal links with water and land are what can bind us in common purpose.

...Trees, as has been explained in this book, are a very vital part of natural water cycles. There are many sayings about trees being something we plant today for posterity. That is true, but we humans do live long enough to celebrate

Jan Lambert photo

"I've got peace like a river." A nature path through a buffer zone, above, created from an eroding edge of an agricultural field, leads one through flourishing plants. Trees in the foreground were planted as small seedlings by volunteers 13 years previously. Native shrubs, such as dogwood, below, offer nutritious, vital sustenance for migrating flocks.



the fruits of our labors. In 2002 I helped to create a buffer zone of thousands of trees, shrubs and other plants along the Connecticut River in my town of Charlestown, New Hampshire (USA). We planted very small tree seedlings in a featureless, over-used hay field that was literally falling into the river in great chunks each year. The years have paid off, and this area is now transformed. Today healthy native maples, pines, and oaks are already up to thirty feet high, providing many nesting places for the abundant birds, and curbing the once-rampant erosion. Dogwood shrubs we planted are loaded with the succulent fruit so needed by migrating flocks. And of course I know that there is much increased water there, as the vegetation welcomes each rain, stores it, and continually releases it gradually back into the river and the sky, as nature intended, and that the soil is building, not washing away. I find it very spiritually uplifting to have been part of creating this oasis, this Eden.

... Water constitutes the great majority of our bodies (up to 99%, depending on how you measure it!) That is why we quickly perish from dehydration when we are denied water. Our need for water "spills" over into our language. We "thirst" for knowledge, and are only satisfied when we are "saturated." We caution that it is not good to "muddy the waters," but we admire and yearn to delve into a "deep pool" of knowledge.

...I think our ancestors, close to our roots in nature, intuitively realized just how central water is, because it is inextricably twined with major religions. In my own

Christian faith, we often hear about water in the scriptures, for example , as when we are advised, "And whosoever shall give to drink unto one of these little ones a cup of cold water ... shall in no wise lose his reward." *(Matthew 10:42)*. And the central role of water, in the sacred rite of baptism, combines the physical and the spiritual into one. The Hindus consider all water to be sacred, and have many rites using water. In Islam water is important for cleansing and purifying. In Judaism ritual washing is intended to restore or maintain a state of ritual purity. Shinto is Japan's indigenous religion, in which waterfalls are held sacred and standing under them is believed to purify. At Buddhist funerals, water is poured into a bowl; as it fills and pours over the edge, the monks recite "As the rains fill the rivers and overflow into the ocean, so likewise may what is given here reach the departed." And indigenous peoples, such as Native Americans, know that water is sacred and water is indeed life.

...Water is the great unifier. We all depend on it; we are water. Let us help each other and the Earth heal, with water. Let us help restore Nature's water cycles, by uniting with our neighbors in the similar spirit that arises within us to unite with our neighbors in the aftermath of natural disasters, but instead to prevent natural disasters.

...My good friend and co-author, Michal Kravčík says, "Water is a gift from God, and we should, after using this gift, return the water to God." We can show our re-found reverence of water by allowing Nature's miraculous water cycles once more to function. Instead of rivers suffering as polluted torrents from water running wastefully off the land, we can help rivers to return to their rightful channels of peace, so that we can rejoice as in the familiar African-American spiritual song, "I've got peace like a river, I've got peace like a river, I've got peace like a river in my soul."

...May peace flow into your mind and spirit as from a never-failing spring of cool water!

Jan Lambert
September 2015

Jan Lambert photo

The Connecticut River in Charlestown, New Hampshire (USA), like all rivers, can bring peace to us all if we only respect and care for the rain that falls on our landscapes.

RETAIN THE RAIN, RESTORE OUR LANDSCAPES, RENEW OUR CLIMATES

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Forest- Slovakia *Jozef Matúš photo*

Urban- South Korea *Michal Kravčík photo*

Wildlife Habitat- *Cuenca Los Ojos* *Jan Schipper photo*

In Slovakia, catchments are built to infiltrate rainwater in forests.

In South Korea, rooftop gardens absorb rain and raise food.

In North America, wildlife benefit from rainwater retained by check dams.

In the USA, swales capture rain into farmland.

Agriculture- USA *Greg Judy photo*

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Jan Lambert photo

Lowell Lake State Park, Vermont USA.

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Grassroots connections – agriculture, communities, nature

SPECIAL BOOK EDITION

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