**Climate-Resilient Lowland Stream Valley: explaining the Infographic**

**Climate change is a hot topic. We will to have to adapt and be prepared for more extreme weather events with excessive precipitation and prolonged droughts. This has consequences for our streams and rivers. But if we want to know HOW we can make stream valleys climate-resilient, we first need to know WHAT that means. The infographic on climate-resilient stream valleys – drawn up by experts – is a useful aid.**

Most stream and river basins in the Netherlands have been drained. Streams have been straightened, overdimensioned and regulated with weirs and land uses have become more intensive. Streams are modified to optimise discharge capacity and groundwater levels, but these regulated channels are not designed to accommodate sudden peak flows and compensate for longer periods of water deficit. This has become increasingly obvious in recent years. Moreover, these adjustments have led to a deterioration in water quality, a loss of biodiversity and poor natural functioning of the Dutch streams and their surrounding valleys. The Streams and Rivers Community of Practice argues for an integrated approach to creating climate-resilient stream valley landscapes in the most natural way possible. The basic principle is *natural wherever possible, engineered where necessary.*

**Imbalance**

The originally natural linkage between underlying geography (the soil and water system) and land use became increasingly out of balance over the course of the last century: the present pattern of land uses now seems to bear little to no relation to the carrying capacity of the soil and water resources. The understanding that a stream, its basin and surrounding valley is a system in which everything is interconnected by the soil and water system, from the upper to the lower reaches of the stream, has apparently been lost. This insight into the physical system and its use or abuse is essential for devising a more climate-resilient way of living and working in stream valleys.

Current projections of climate change make it even clearer that we can no longer do everything everywhere. The present layout and use of the landscape is incompatible with what is needed to maintain a healthy and well-functioning stream ecosystem and valley landscape. Climate change just adds to the problems we were already facing: exhaustion of the soil, flooding, water shortages and heat stress. A more climate-resilient use of the land must include remedies for both water surpluses and water shortages.

**Conditions**

Necessary conditions for stream valleys to function more naturally are the restoration of the soil so that it can retain water for longer, a buffered discharge of peak flows and sufficient minimum discharge for dry periods, a free runoff and good water quality. The stream and its valley must be connected via gradual land/water transition zones.

But how can all this be accommodated in a densely populated landscape with a patchwork of urban, industrial, agricultural and natural areas? And how can we ensure that as a society we accept this and act upon it?

The philosophy for choosing the measures to be taken is based on the principles of retaining, storing and discharging water. Water retention is a measure for the higher ground in the upper parts of the valley. Moving further downstream the approach is increasingly geared towards storing water and then discharging water. A key aspect of this philosophy is combining a variety of measures: combinations of measures are able to offset the consequences of climate change (changing seasonal patterns and extreme precipitation, drought and warming) as effectively and naturally as possible. The choice of measures therefore depends on the location, while also taking land use into account.

**Examples**

Examples of how this can be achieved can already be found at several places throughout the Netherlands. In the province of Limburg plans have been drawn up to make the Loobeek valley climate-resilient and to create a climate buffer in the Geul valley. For the Loobeek there is a broad package of measures to be implemented by the provincial government, the municipality of Venray and the water authority working together. The added value is that objectives for water, nature, farming, urban areas and recreation can be packaged into smart combinations and actions taken that a single governmental body would not be able to do on its own.

In the valley of the Geul the aim is to restore the channel from its source to where it enters the river Meuse, which will increase natural water retention and storage by slowing down rainwater runoff and retaining groundwater. Water quality will be improved by adapting farming methods and reducing soil erosion. All this should increase biodiversity and make the landscape more attractive, in turn increasing its recreational value.

**Cross-border cooperation**

When planning and implementing effective measures it is important to be aware of cross-border benefits and implications and to initiate cooperation with the relevant authorities on all aspects. Administrative boundaries are just one. For example, where will a measure be most cost-effective? In our management area or within the boundaries of the adjacent municipality, province or water authority? And should this measure be taken by public authorities, or is it up to other stakeholders? The choice of measures to be taken also depends to a certain extent on land use. Will the existing land use be appropriate under future climatic conditions, or should it become more extensive? However, focusing too much on a single land use or function from the perspective of one particular public authority will lead to an unbalanced hotchpotch of measures with limited benefits.

**Infographic**

All this is illustrated in the Climate-Resilient Lowland Stream Valley Infographic. This presents an invitation to build climate resilience into the basins of streams and rivers as outlined above. The illustrations for the infographic were made by Ronald van der Heide.

A stream valley is an ecosystem in which everything is interconnected – longitudinally from the upper to the lower reaches; laterally from the valley to the stream; vertically from groundwater to surface water – with buffer zones where ecosystem functioning and land uses affect each other. Once the natural processes are known, they can be taken into account. On the higher, drier ground this means retaining every drop of rainwater for as long as possible. In natural habitats this is done by abandoning artificial drainage systems and allowing marshland to develop; in agricultural areas this can be done by taking measures to improve the water retention capacity of the soil, possibly with the help of more technical measures. But it may also mean having to alter land uses and water uses or accepting certain consequences of climate change.

**Approach**

The range of measures presented in the infographic illustrates a particular approach and does not pretend to be exhaustive. Each stream or river basin will require its own unique combination of measures.

**Climate-resilient stream valley landscapes**

In rural areas, a natural approach makes use of the **sponginess** of the valley soils. How is this done? By restoring marshes, retaining water – which replenishes the groundwater – planting wooded buffer zones along the banks, and creating space for riparian and aquatic vegetation and wood in the streams; by narrowing the streams and letting them meander to reduce the bed slope; and by giving free rein to natural processes such as flooding, vegetation growth and sediment transport. Room must be created for these processes, which may involve changes or rearrangement of land uses.

The measures to be taken change gradually from water retention via water storage to water discharge. This shift occurs along two gradients: along the course of the stream from the upper to the lower reaches, and across the valley from the infiltration areas at higher elevations to the stream.

**Farmland: climate-resilient agriculture**

Wherever agricultural activities are located in the stream landscape, they should be in line with the local carrying capacity of the water and soil system. Natural measures can help to minimise the impact of more intensive agricultural activities on the stream and the riparian zone. One such measure is to establish gradual transitional zones. Buffer zones along the banks are effective and, depending on the type of vegetation, can provide shade for the stream. Retention areas can mitigate consequences of drainage and improve water quality.

On higher ground the ‘farmland version’ of spongy soils and marshes hold potential: shallower ditches with weirs and soil management.

**Urban areas: climate-adaptive urban design**

As space is severely limited in urban areas and water levels must meet specific requirements, most measures will be **hybrid** solutions with a mix of natural and technical measures. But here, too, there are opportunities to retain water and replenish groundwater levels through infiltration. Measures include green roofs, permeable hard surfacing and creating room for water, for example in green spaces. Retaining additional water in towns and villages will thus make a valuable contribution to combating drought and extreme heat. The benefits to nature are mainly local and the benefits to the stream and the stream valley are delayed drainage, improved connectivity and a modest improvement in water quality.

Figuur bijschriften

RETAIN > STORE > DISCHARGE

CLIMATE-RESILIENT AGRICULTURE RESTORE THE NATURAL SYSTEM

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| reduce drainage | water storage | | climate-resilient crops | |  |  |
| precision irrigation (robot-assisted) | increase organic matter content | |  | |  | reforestation |
|  |  | |  | |  | fill in ditches |
|  |  | |  | |  | marshy stream / floodplains |
|  |  | |  | |  | riparian shading |
|  |  | |  | |  | remeandering |
| FROM UPSTREAM TO THE LOWER REACHES | | | | |  |  |
|  | |  | |  |  |  |
|  | |  | |  |  |  |
| CLIMATE-ADAPTIVE CITY | | | | |  |  |
|  | |  | |  |  | restoration of groundwater flows |
|  | | | | |  | sustainable soil management |
| replace impermeable surfaces | |  | |  |  | biological crop protection |
| disconnect rainwater drainage | | water storage in streets + public spaces | |  | FROM THE VALLEY SLOPE | helophyte filters |
| swales | | green roofs | | buffer zones |  | near-natural stream cross-section |
|  | |  | |  |  |  |
|  | |  | |  |  | |
|  | |  | |  |  | WATER QUALITY IMPROVEMENT |