The Invisible Ditch Draining Our Rivers

Why infrastructure designed to protect a road can, at the scale of a watershed, amplify floods, accelerate the drying of the land, and increase its vulnerability to wildfire

> ***"For more than a century, we built infrastructure to evacuate water. The 21st century now requires us to learn how to retain it, slow it down, and direct it."***

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A NEW WAY OF THINKING ABOUT 21ST-CENTURY INFRASTRUCTURE

A few years ago, on a forestry worksite, I watched a recently installed culvert fail under a rainfall that, ten years earlier, would probably have concerned no one.

In a single night, the water had carved out a gully nearly three metres deep and swept away a section of road we had just finished building.

For a long time, I treated events like this as accidents caused by exceptional rainfall. But after more than thirty-five years building access roads, managing large forested territories, and contributing to the planting of more than one hundred million trees, I have seen this scenario repeat itself too often to keep treating it as a simple anomaly.

Rainfall has changed. Its frequency, intensity, and distribution are shifting.

But that is only part of the problem.

The other part, harder to recognize, is that the way we have been building roads for more than a century can amplify the very phenomenon it is meant to control.

> ***We optimized the asset — the road — without always measuring that asset's cumulative effect on the system it sits within: the watershed.***

A good response to a real problem

Conventional road engineering deserves to be understood fairly first.

The principle of drainage was not born from an error or negligence. It responds to a very concrete problem: saturated soil loses part of its bearing capacity. Water trapped within a road structure can freeze, expand, cause deformation, and then contribute to pavement deterioration during thaw.

The logical response was therefore to remove water from the structure as quickly as possible.

We built ditches along roads. We installed culverts. We compacted soils. We used free-draining granular materials and calculated slopes to carry water outside the right-of-way.

At the scale of a single road, this logic is rational.

The problem appears when its effects are added up across an entire territory.

An engineer building a ditch is trying to protect a few hundred metres of road. They are not intentionally designing a system meant to drain a watershed. Yet when thousands of kilometres of roads, ditches, and culverts are connected to one another, that is exactly what we can end up creating:

> ***A second drainage network, superimposed on the natural stream network.***

The road network becomes a hydrological network

This phenomenon is not merely a field observation.

Forest hydrology research has documented it for several decades.

In two watersheds studied in Oregon, researchers observed that up to 57% of the total road network length could function as a genuine flow path. [1]

Some segments carried water directly to streams. Others concentrated runoff enough to create new erosion gullies that did not exist before the road was built.

A ditch, then, is not merely equipment meant to keep a road dry.

At the landscape scale, it becomes an artificial branch of the stream network.

It intercepts water that would normally have been slowed by vegetation, absorbed by the soil, or spread across a wide area. It concentrates that water, accelerates its movement, and directs it toward a limited number of discharge points.

This concentration can produce two consequences that appear opposite but stem from the same mechanism:

- too much water, too quickly, during heavy rainfall;
- too little water retained in the territory during the dry weeks that follow.

In other words, the same infrastructure can contribute to higher peak flows during wet periods and a reduced water reserve during dry periods.

Where a road sits changes everything

A study conducted in the Caspar Creek watershed, in California, helps measure how much a road network's position relative to streams matters. [2]

Researchers compared two generations of roads built on the same territory.

In the older network, built before 1974, about 58% of roads were located immediately adjacent to a stream. According to the modelling, this configuration could increase peak flows by as much as 46% compared to a no-road scenario.

In the more recent network, only 13% of roads were located near streams. The modelled increase in peak flows then fell to less than 2%.

57% of the studied road network could act as a flow path	**+46%** peak-flow increase for an older network built close to streams	**< 2%** for a newer network repositioned away from the hydrography

Figures drawn from the studies cited in references [1] and [2].

The material used to build a road matters.

The construction method matters as well.

But its position within the watershed can matter just as much.

A perfectly built road, when poorly positioned relative to the natural hydrography, can remain a hydrological problem.

This should change how we evaluate an access corridor. The question should no longer be only:

> ***Can this road support the expected traffic?***

It should also be:

> ***How will this road change the movement, infiltration, and storage of water across the entire territory?***

A road can also become a fence

A road does not need to run alongside a river to change a watershed's hydrology.

On a hillslope, water does not move only at the surface. It can also move laterally through soil layers, following the slope and gradually feeding the areas farther downhill.

When a road cuts across that slope, its compacted footprint and its ditches can act as a hydrological fence.

Water that would normally have moved slowly across a wide area is intercepted. It is then redirected into a ditch and concentrated toward a culvert or another discharge point.

Diffuse infiltration becomes concentrated runoff.

Even when a road sits several kilometres from a major stream, it can still change:

- the distribution of soil moisture;
- the recharge of certain zones;
- the speed at which water reaches downstream areas;
- the hillslope's ability to hold a reserve during dry periods.

This is one of the least visible aspects of the problem.

We easily notice a road washed out by a flood. We notice far less easily the water that never entered the soil because a road intercepted and evacuated it.

The silent loss beneath our feet

When a road network accelerates the evacuation of water, the consequence is not limited to the rainfall event itself.

Some of the water that could have infiltrated and contributed to groundwater recharge leaves the territory more quickly.

The U.S. Forest Service describes how poorly located roads can drain local groundwater storage, transmit runoff more quickly downstream, and leave too little reserve to sustain late-season flows or get through a drought year. [3]

This reserve is invisible, but essential.

It sustains streams once the rain stops. It maintains soil moisture. It supports the health of trees, wetlands, crops, and the communities that depend on the same resource.

When we rapidly evacuate water from a watershed, we are therefore not simply moving a problem elsewhere.

We can also be removing part of the territory's capacity to withstand the next climate shock.

The reference climate has changed

Road-drainage doctrine was developed in a context where infrastructure was mainly evaluated on its ability to bear loads, resist frost, and remain passable.

Those objectives remain essential.

What has changed is the climatic context in which this infrastructure must now operate.

In many regions, a growing share of precipitation arrives as intense, relatively short events, separated by longer dry periods. Water may fall in abundance, but the territory does not necessarily receive it when it needs it most.

Under this regime, infrastructure designed to evacuate water as quickly as possible can become particularly poorly suited.

It expels water during intense events.

It increases how quickly that water reaches rivers.

It reduces the time available for infiltration.

Then, once the dry period begins, some of that water is no longer available in the soil.

The same territory can experience a flood in spring and a moisture shortage a few weeks later.

This is not a contradiction.

It is the result of a system that moves water too quickly rather than retaining, slowing, and distributing it.

This is not about building less

The answer to this problem is not to eliminate all roads.

Communities, forestry companies, energy networks, mines, emergency services, and remote regions all need access infrastructure.

The real question is whether we can keep building with a doctrine that treats water almost automatically as an enemy to be expelled.

I believe we need to evolve our definition of high-performing infrastructure.

In the 21st century, an access corridor should no longer be evaluated only on:

- its bearing capacity;
- its construction cost;
- its service life;
- its ease of maintenance.

It should also be evaluated on:

- its influence on runoff;
- its contribution to infiltration;
- its effect on aquifer recharge;
- its ability to avoid concentrating water;
- its impact on the soil after removal or end of life;
- its contribution to watershed resilience.

This new way of thinking is the starting point of what we call Regenerative Access Infrastructure.

From evacuation to orientation

Regenerative access infrastructure is not a road that blindly retains all water.

It is designed to direct water intelligently.

It must protect the structure while avoiding, as much as possible, draining the territory.

It seeks to slow, distribute, infiltrate, and, when necessary, filter water close to where it falls.

This orientation echoes “sponge city” and “sponge planet” approaches, which seek to retain, slow, and welcome water rather than expel it. [4][5]

This requires revisiting several decisions that today are often made separately:

1. Corridor position

The road must be designed according to the natural hydrography, not solely according to the shortest distance or the lowest initial cost.

2. Bearing capacity

We need to develop structures capable of distributing loads without systematically requiring excavation, deep compaction, and drying out the natural soil.

3. Water distribution

Rather than concentrating runoff toward a few culverts, infrastructure can favour lateral infiltration distributed over a greater length.

4. Seasonality

In northern climates, the structure should also be designed to extend, where possible, the period during which water can penetrate the soil before freezing closes the annual infiltration window.

These principles are already at the core of the modular corridors we develop at Beyond Sustainable Tech: structures placed on the soil surface, connected to distribute load, and designed to enable more distributed water management. But the challenge extends well beyond any single company or technology.

> ***It is about evolving an entire discipline.***

A hypothesis to be tested, not a dogma to be imposed

I am not claiming that every conventional road automatically dries out a watershed.

Nor am I claiming that a single technology can solve the entire problem.

The effects depend on soil type, slope, vegetation cover, climate, road position, network density, and how water is directed.

But the available data justify a serious question:

> ***By protecting each road individually against water, have we adequately measured the cumulative effect of all these roads on the territory's capacity to retain that same water?***

This question now needs to be studied by hydrologists, civil engineers, forestry engineers, Indigenous communities, municipalities, universities, and owners of large infrastructure.

Future pilot projects should be instrumented to measure, among other things:

- soil moisture upstream and downstream of the corridor;
- water residence time;
- peak flows;

- groundwater recharge;
- soil temperature;
- vegetation development;
- water quality;
- the infrastructure's structural performance.

Measurement is essential.

It is what will determine where this new approach is relevant, where it needs to be adapted, and how it might eventually contribute to the evolution of engineering standards.

Building for the climate ahead

Drainage engineering was not a mistake.

It was a rational response to a real problem, given the conditions and technologies available at the time it was developed.

But a solution designed for one climate regime does not automatically remain the best solution for the next one.

For more than a century, we learned to build infrastructure to evacuate water.

The 21st century now requires us to learn how to retain it, slow it down, and direct it.

A road should no longer be considered a structure isolated from the territory it crosses.

It is part of the watershed.

It influences how water moves.

It can contribute to concentrating a flood or distributing a recharge.

It can accelerate the drying of a soil or contribute to its resilience.

The first step is not to claim that we already have all the answers.

The first step is to recognize the question.

> ***What if our access infrastructure could serve the land, instead of simply crossing it?***

NEXT ARTICLE

Wildfire risk is not read only in the sky, but also in the soil. The next article will examine why soil moisture is becoming a key predictor of fire behaviour, and how the progressive drying of a territory can alter vegetation condition, fuel loads, and an ecosystem's overall resilience.

OPEN QUESTION

If you work in civil engineering, forestry, hydrology, municipal management, or infrastructure operations: when was the last time a road project at your organization was evaluated for its effect on the watershed — and not only for its own structural performance?

ABOUT THE AUTHOR

AB

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For more than thirty-five years, he has worked in forestry, land management, and the development of environmental technologies. He is co-founder and CEO of Beyond Sustainable Tech, a member of Top Tier Impact, and is working on launching the Global Initiative for Regenerative Watersheds as well as structuring the concept of Regenerative Access Infrastructure.

KEY REFERENCES

The links below were accessible at the time this document was prepared, in August 2026. Click the title or the address to open the source.

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