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nsational Forestry Management Strategies in Resp
Regional Climate Change Impacts

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Runoff in Afforestations and in Established Forests in SW-Germany:

Process Identification by Sprinkler-Irrigation Experiments

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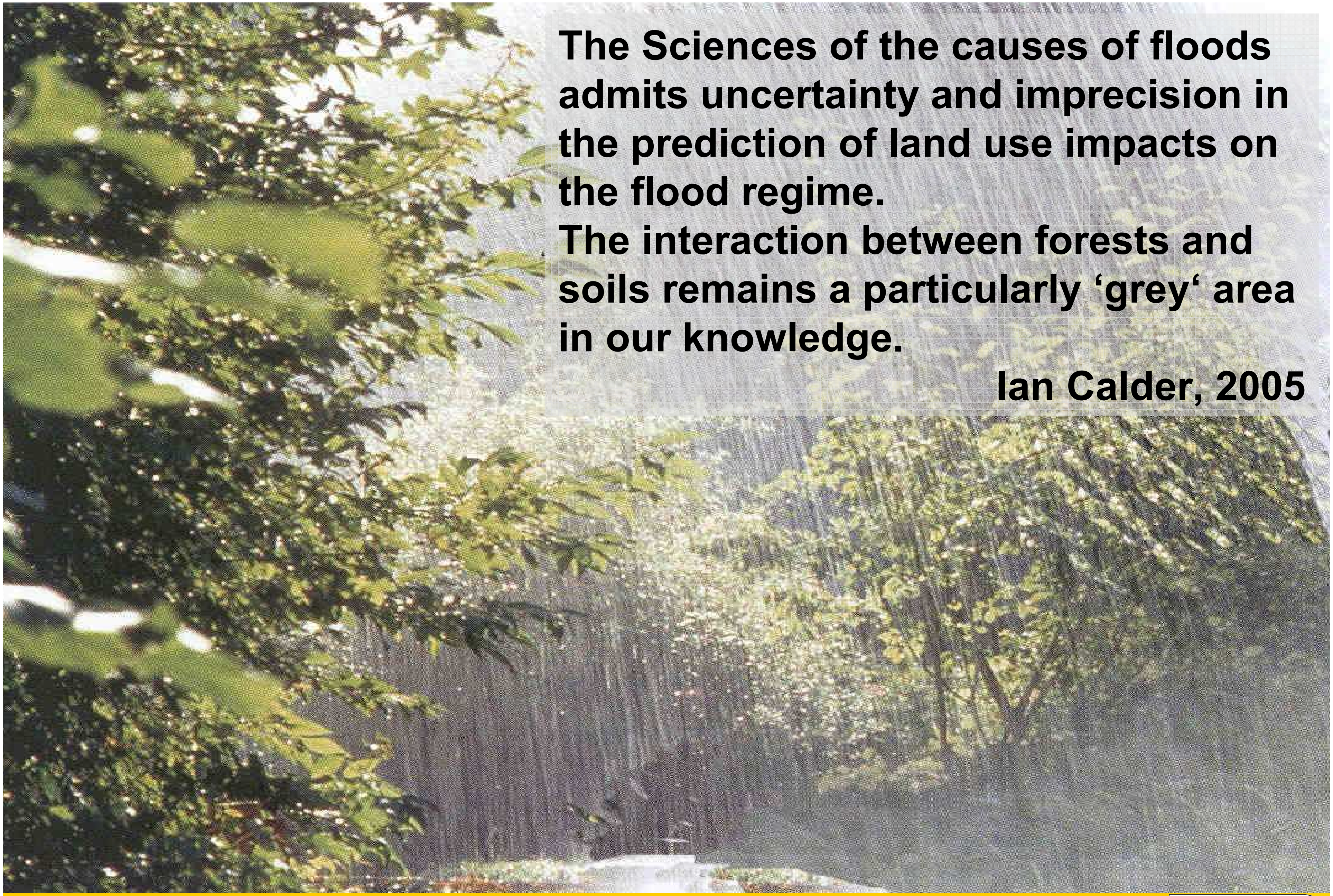

The Sciences of the causes of floods admits uncertainty and imprecision in the prediction of land use impacts on the flood regime.
The interaction between forests and soils remains a particularly ‘grey‘ area in our knowledge.

Ian Calder, 2005

Within the European INTERREG-projects - ForeStClim and WaReLa - water retention functions are being investigated that depend on landscape features and land-use. The results of our investigations lead to digital maps identifying sensitive forest sites to adapt forestry measures to a changing climate in view of flood mitigation.

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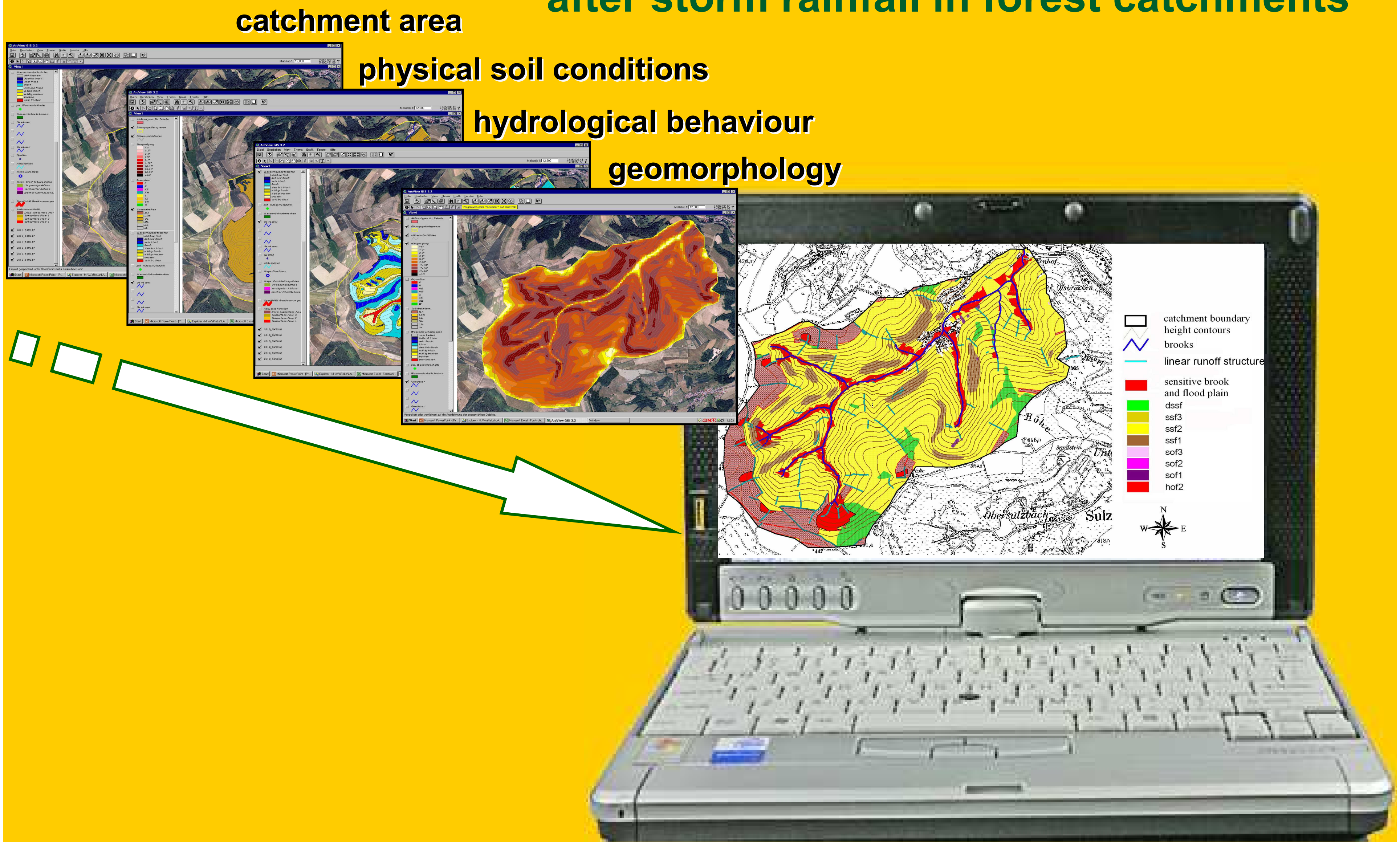
Aim of the investigations: “digital map with the runoff generation after storm rainfall in forest catchments”



2nd International Conference on Forests and Water in a Changing Environment

September 14 – 16, 2009 Raleigh NC, USA

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WaReLa

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Project Area
= INTERREG NWE
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2nd International Conference on Forests and Water in a Changing Environment

September 14 – 16, 2009 **Raleigh NC, USA**

I. Investigation sites in the headwater catchment of the "Frankelbach"

1. 1-year old afforestation (with Alder, Linden, Maple and Oak on former pasturage)

2. 30-years old afforestation (with oak and hornbeam on former agricultural land)

3. established deciduous forest with oak, beech and hornbeam

4. 40-years old Douglas fir afforestation (on former agricultural land)

5. established coniferous forest stand

Site conditions in the „Frankelbach“ headwater catchment

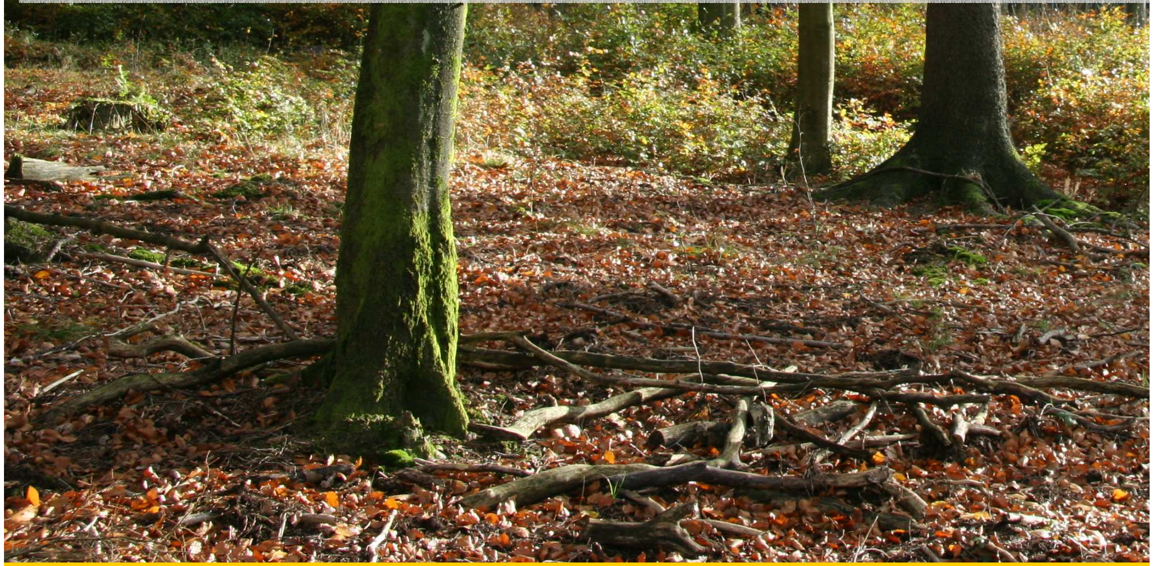
The headwater catchment **area** of the Frankelbach is about 8 km^2 large.
The **height** above sea level is 210m to 430m.

Precipitation: 700 - 800 mm/year with a cumulation of storm rainfalls during summertime in the last decade.
Average temperature: 9° Celsius
Average temperature during vegetation period: 14° Celsius

Geology: Permian era (296 – 258 Mio years); New Red, so-called “Rotliegendes”
Sediments were deposited during semiarid and subtropical conditions and later bulged by volcanism
Soils: Brown earth / colluvia from sand-loam, silt-loam, partly relocated, (in the valleys loamy floodplains)

I. Investigation sites in the headwater catchment of the "Holzbach"

1. old Beech stand on the upper slope
2. old Beech stand on the middle slope
3. old Spruce stand on the upper slope
4. old Spruce stand on the middle slope



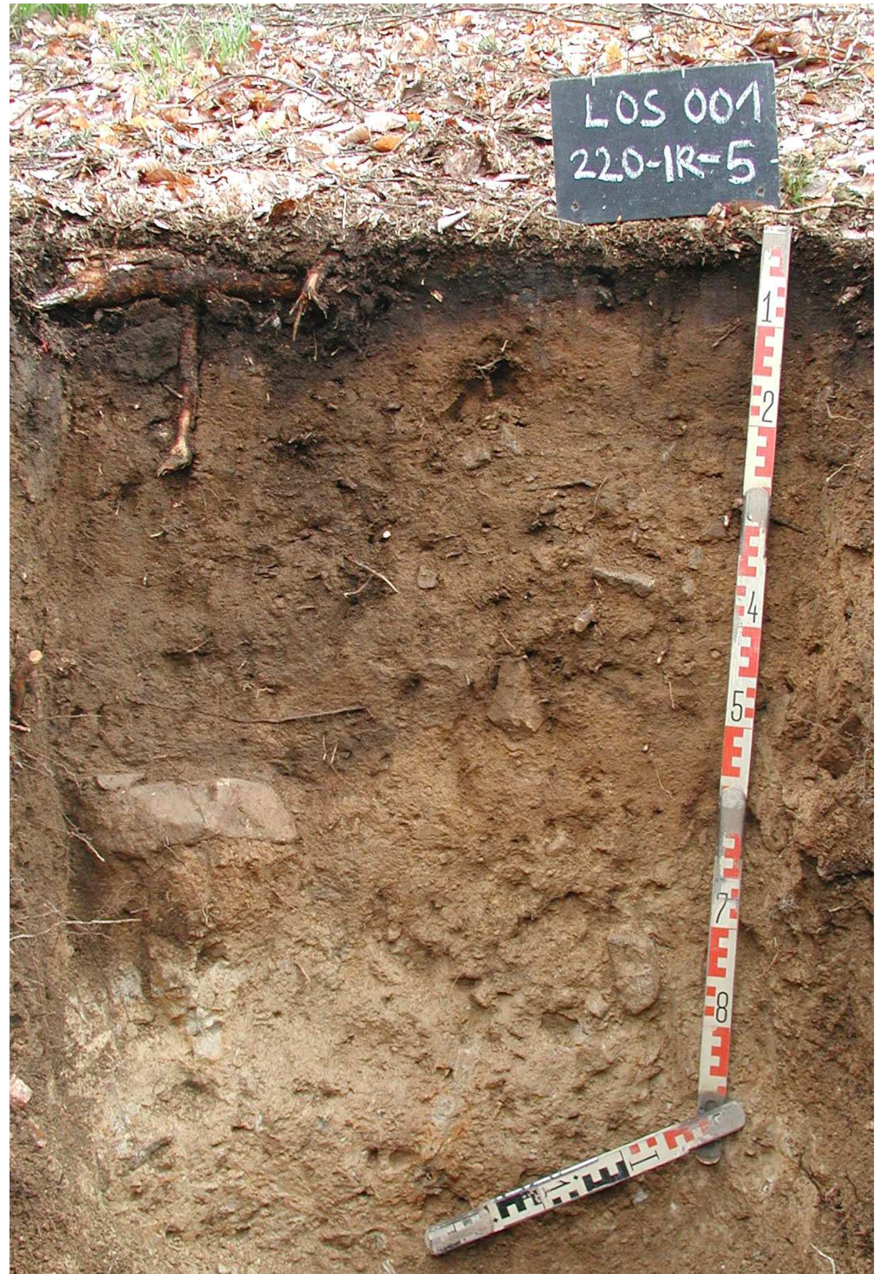
Site conditions in the „Holzbach“ headwater catchment

The headwater catchment **area** of the Holzbach is about 4.2 km^2 large.
The **height** above sea level is 400m to 650m.

Precipitation: 950 - 1200 mm/year
Average temperature: 6° Celsius
Average temperature during vegetation period: 10° Celsius

Geology: Paleozoic era with series from Devonian (290 Mio years);

Soils: Podsols / brown earths / gleysols from quartzite-loam, gleyic quartzite-loams, periglacial loams above Quartzite-loams,



Sprinkler-Irrigation Method

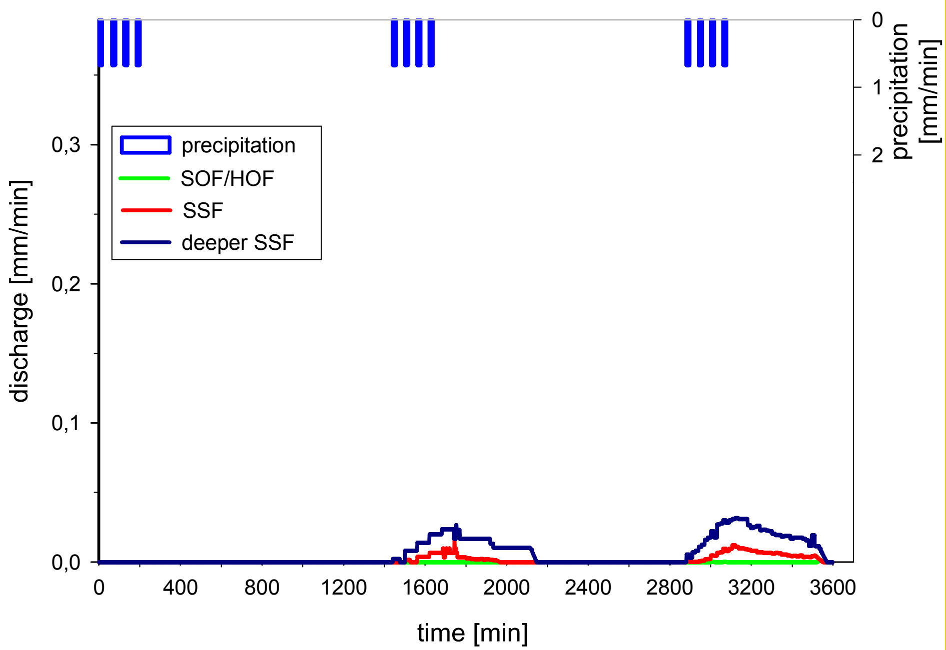
Sprinkler-irrigation experiments have found a widespread use for explanation of runoff processes and to differentiate the runoff behavior of different sites.

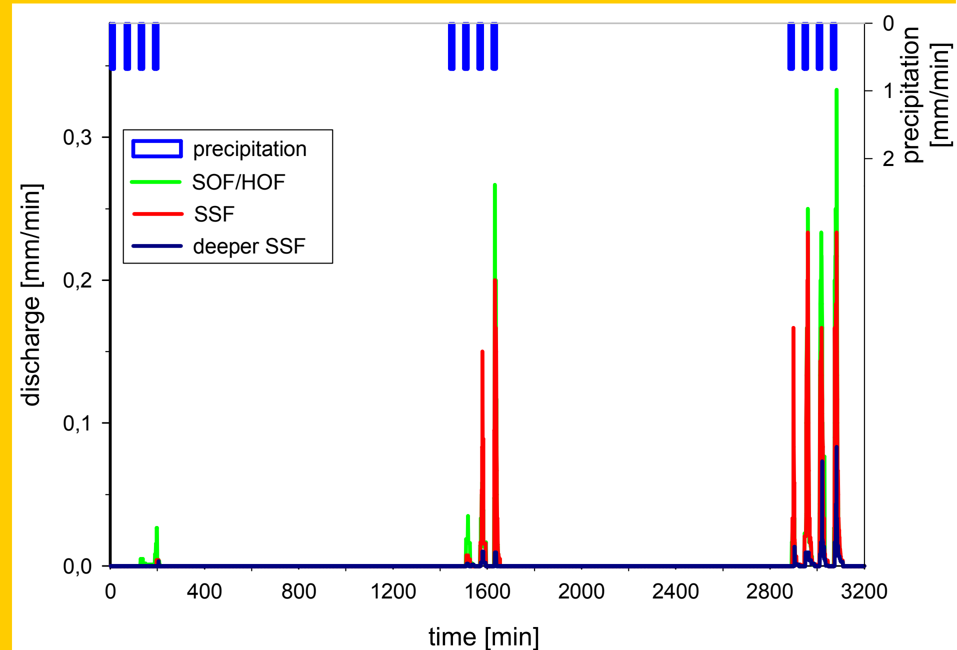
Slope scale simulations were carried out on moderately sloped test areas of 5 x 10 m (effective 3 x 10 m). Per day an amount of 40 mm rainfall was applied during a period of 3 days in 4 intervals of 15 min duration, resulting in rainfall intensities of approx. 10 mm 15 min^{-1}. Surface and subsurface water flow were collected and measured for the middle 3 x 10 m to exclude lateral losses of water.

Results: Discharge types in the Frankelbach catchment

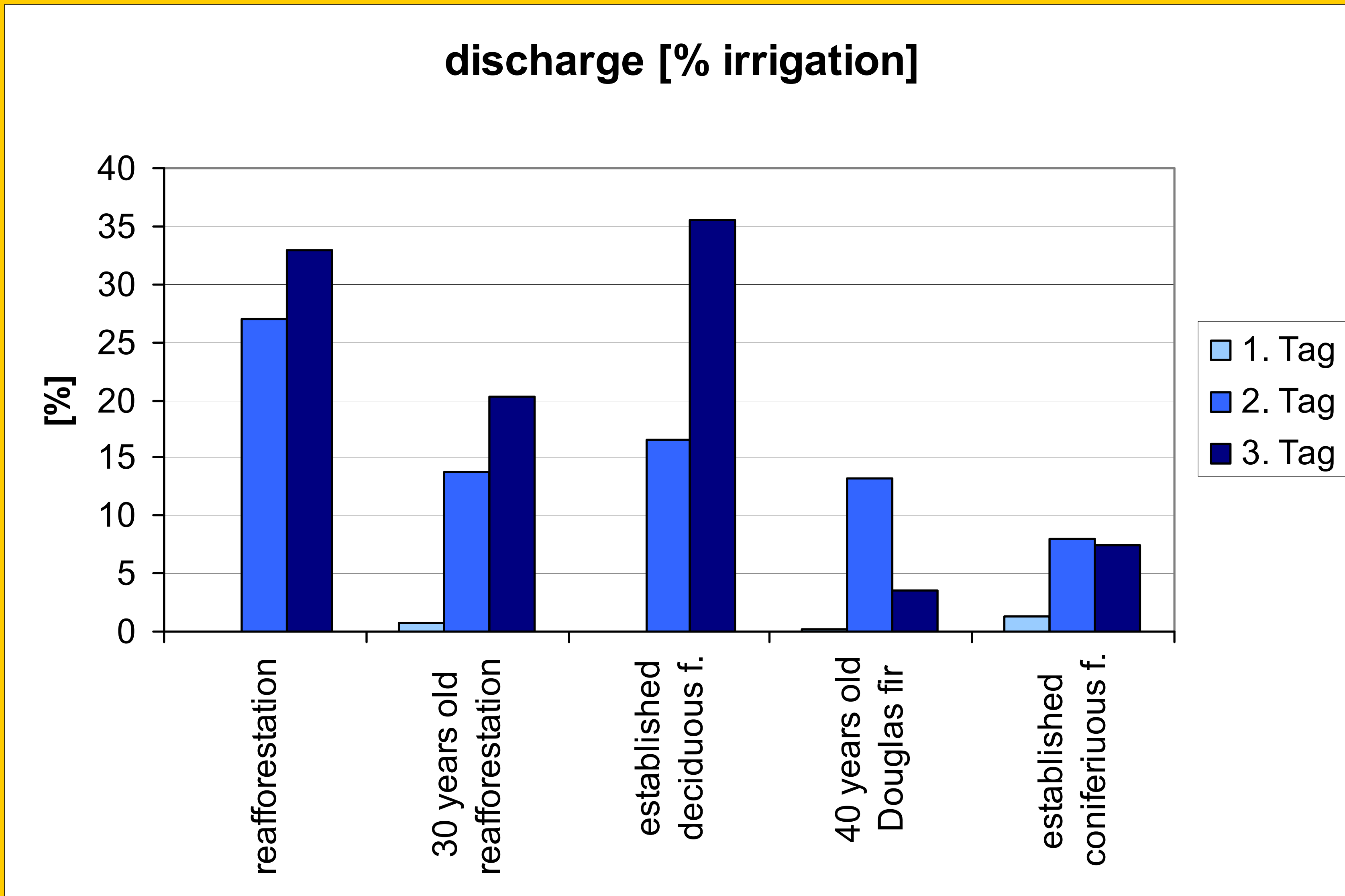
1-year old afforestation

30-years old afforestation

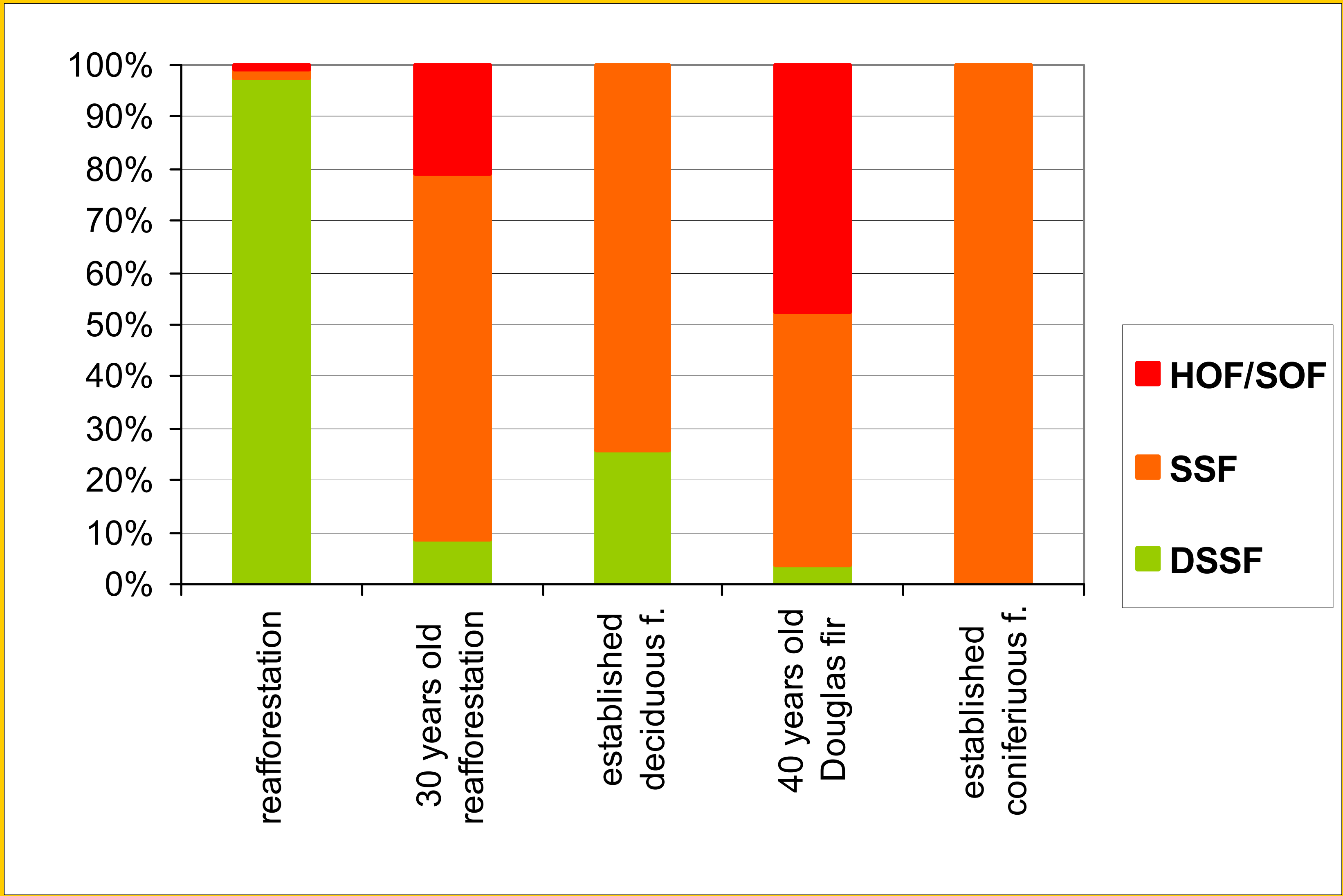




Discharge of different forest types in the Frankelbach catchment



Runoff types in the Frankelbach catchment



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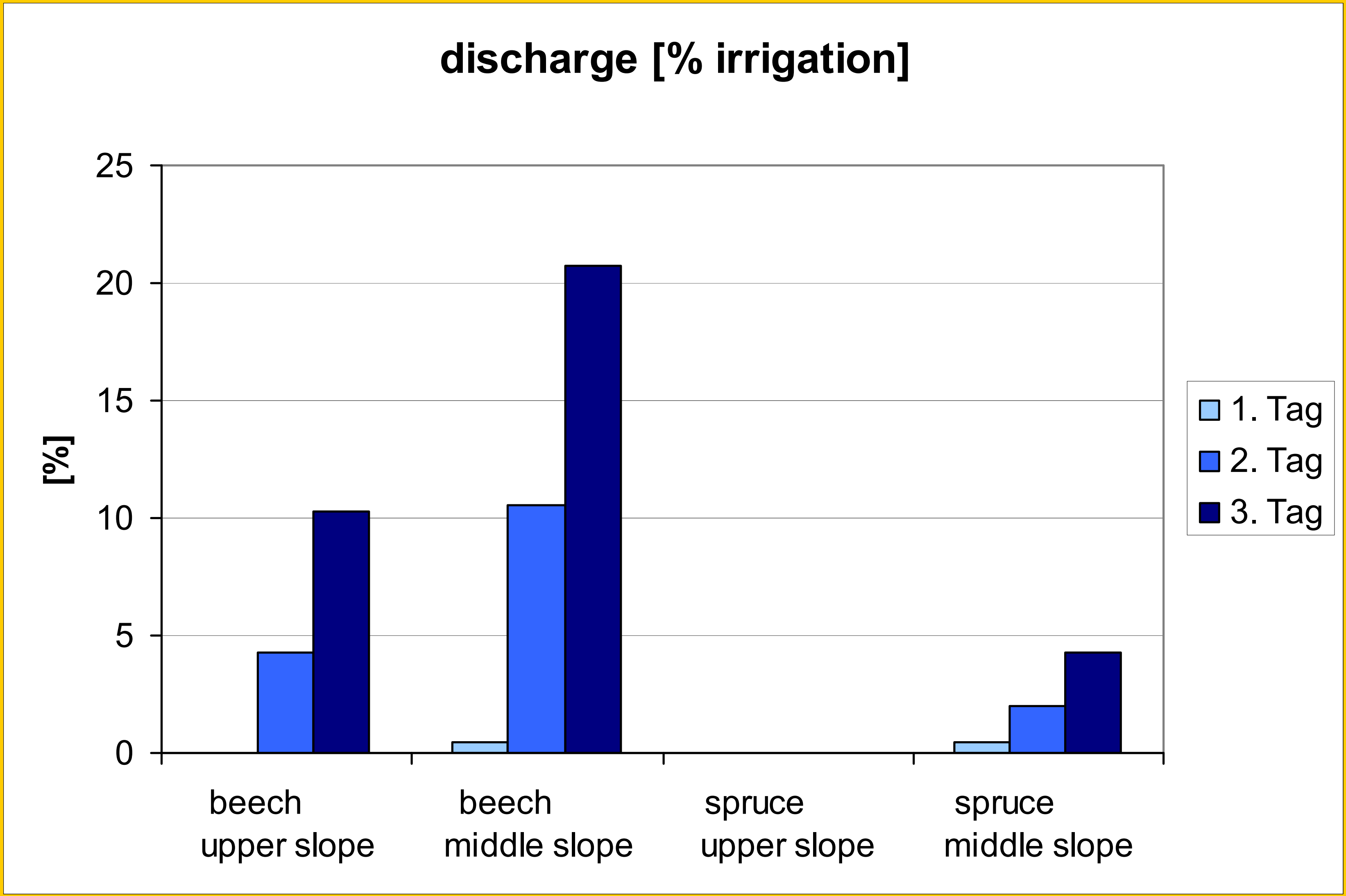
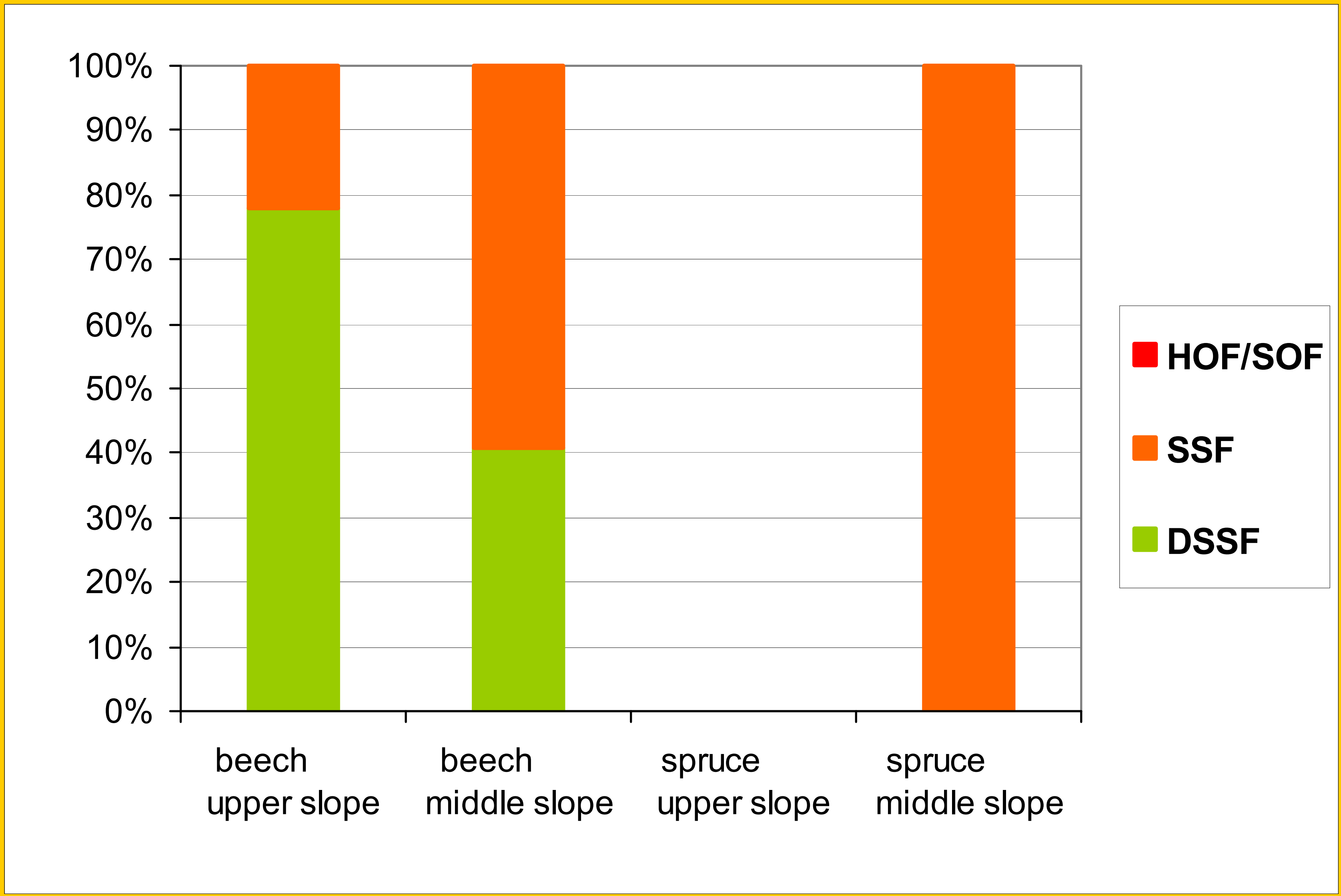
Discharge of different forest types in the Holzbach catchment



Runoff types in the Holzbach catchment



Conclusions (1)

1. From theoretical considerations it would be expected that the **interception** of the tree crowns and the transpiration of trees will regulate flood events;

But the interception (with a moistening capacity of 2 – 6 mm and a saturation capacity of up to 10 mm) is nearly of **no relevance**, compared with the magnitude of flood producing storm rainfalls (> 40 mm/event)

2. The **transpiration** of the tree stands (4-10 mm/day) increases soil moisture deficits, and by this, increases the absorption capacity of the soil;
   - the benefit of forests in mitigating runoff and reducing flood peaks is most pronounced for small, frequent flood events.

But the transpiration of a closed layer of grass vegetation (up to 8 mm/day) is **comparable** to a forest stand. This can be confirmed by the runoff-behaviour beneath the 1-year afforestation in the Frankelbach catchment.

Conclusions (2)

3. The **recent physical soil conditions** are the crucial factor for mitigating fast runoff and reducing flow peaks.

But, the **history of land-use** often teaches us that forests were left on soils with bad soil conditions, e.g. shallow or hydromorphic soils with less field capacity, whereas the better soils were allocated by agricultural land-use.

- thus, the less benefiting soil conditions under forests may have detrimental effects on the runoff behaviour, at least as SSF / DSSF.

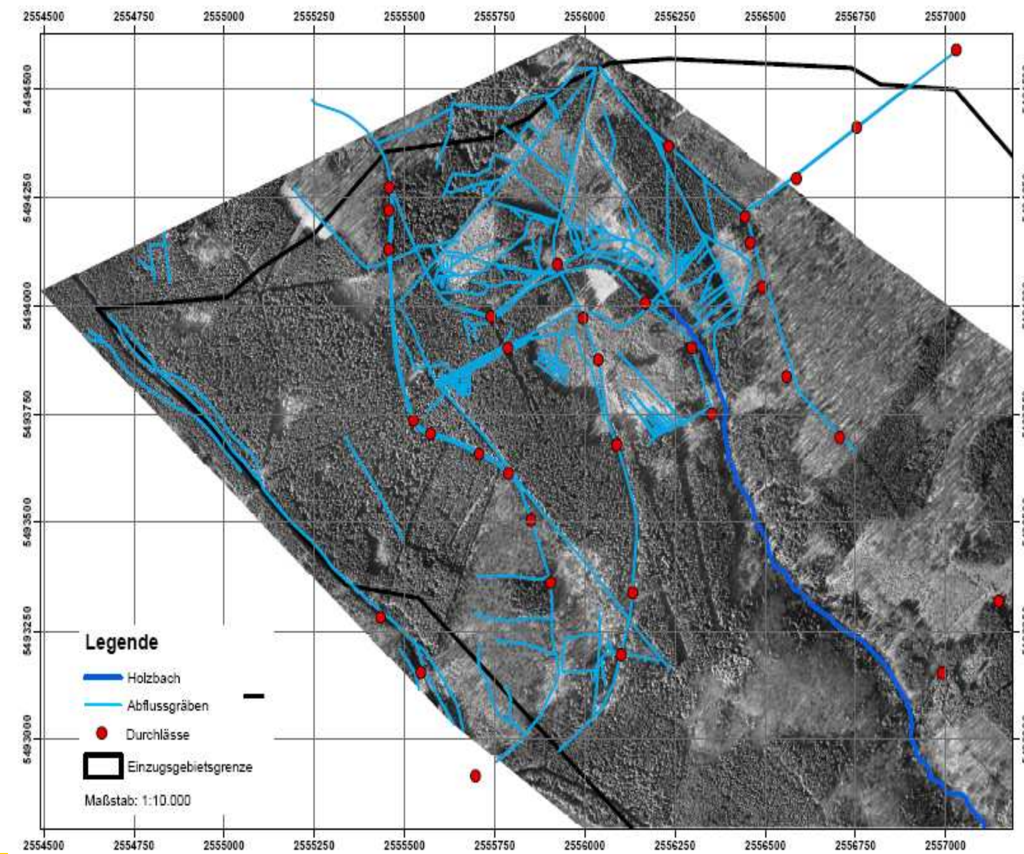
4. Nonetheless the **soils under established forests** are not secondarily compacted. Thus, they tend to be relatively porous with high infiltration and water conductivity rates and consequently reduced incidence of surface runoff and low rates of subsurface runoff.

But, this is not necessarily the case for afforestations:

- whereas the soils under established forests **may take centuries** to evolve and to develop an increasing water storing pore-system, the soils under afforestations still have the soil physical conditions of the former grassland or agricultural soils.

Conclusions (3)

5. Adverse effects on runoff are often related to **forest management acitivities.** They may result e.g. from
   - the forest road network
   - bad logging techniques which compact the soil and increase surface flow
   - pre-planting drainage activities have a great impact on the runoff from forest catchments since they increase the density of water channels. This can increase flood flows and decrease the time to peak and thus cause local flooding problems.



Getting better understanding of the interactions between forest, soil and water as well as of impacts of different land-uses on floods remains an important scientific task.

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Thank you for your attention