# Spread of denudational processes in seepage channels in a postglacial area (north-western Poland)


Małgorzata Mazurek

Geoecology and Geoinformation Institute, Adam Mickiewicz University in Poznań, gmazurek@amu.edu.pl


## INTRODUCTION

In the humid temperate zone, in the lowland area with its high sediment infiltration capacity, groundwater outflows and seepage erosion/groundwater sapping can be the primary mechanism that controls channel initiation (so-called seepage channels). Groundwater outflows through the seepage erosion lead to the development of an amphitheatrical alcove, which often becomes the channel head. A spring-formed alcove is the upper boundary of a concentrated flow of water and sediment transport between well-marked channel margins. The influence of groundwater remains one of the least understood factors in the landform evolution in the postglacial zone of Western Pomerania (north-western Poland).

## AIMS AND METHODS

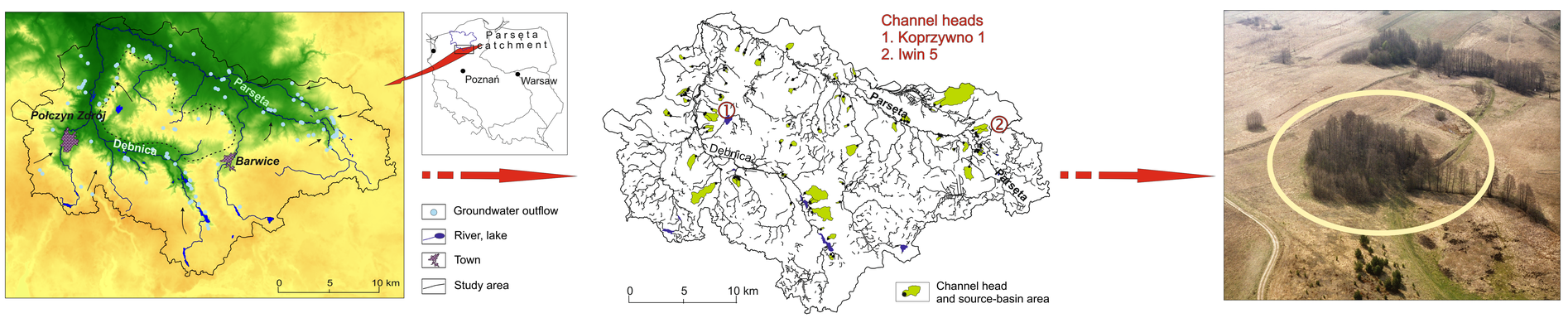
The influence of groundwater remains one of the least understood factors in the landform genesis of postglacial areas in Poland. Lack of data on the geomorphometry of channel heads makes it impossible to identify the nature of the morphological effect of groundwater outflows and their contribution to the formation of channel heads and stream network. The **aims of the study** were: (1) to identify morphological effects of seepage erosion which are combined with surface wash and mass movement processes, and (2) to examine variations in the accumulation conditions, and as a result, a diversity of deposits.

In the southern part of the Parsęta catchment (NW Poland) 1,057 headwater streams have been identified on the basis of a topographic map at a scale of 1:10,000. The study was performed in 88 spring-formed alcoves in which seepage erosion was found to occur. Detailed morphometric, lithological and geomorphological field studies were conducted in selected 24 channel.

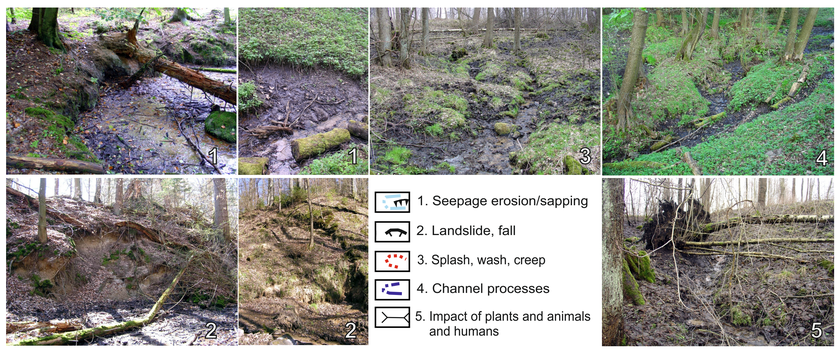
## STUDY AREA

The study area comprises the southern part of the **Parsęta catchment**, which covers an area of 617.2 km$^2$ and is situated in the borderland between the South Baltic Lakeland and the South Baltic Coastal Lowland. In the Parsęta basin's geological structure, a fundamental role is played by the complex of 52- to 214-m-thick **Pleistocene and Holocene deposits**, which comprise five and locally six levels of tills, glaciofluvial sands and gravels, river sands, and ice-dam silts and sands. The surface is covered with loose Pleistocene deposits: tills, glaciofluvial sands and gravels, as well as Holocene river sands, peat and colluvial deposits. The diversity of hydrogeological conditions results in various types of **channel-initiating outflows**. What facilitates contact of ground- and surface water in Pomerania are: (1) a diversified relief and big height differences connected with it, (2) an alternating arrangement of Quaternary deposits in the form of tills and glaciofluvial, fluvial and glacial-lake sediments of varying permeability and thickness, and (3) the discontinuity of aquifers. Outflows largely occurs in the contact zones between glaciofluvial or fluvial sand-gravel deposits, glacial sands or erosion pavement and their underlying semi-permeable tills or poorly permeable loamy sands. The discharge volume of the 88 headwater streams under study varies between 0.01 and 71.76 L/s.

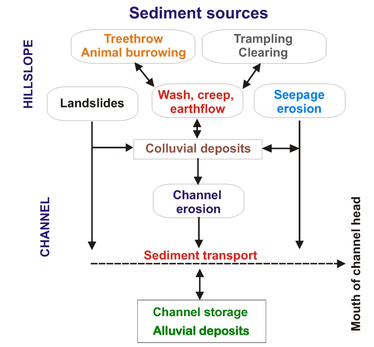
Steady groundwater outflows create favourable conditions for the concentration of water in the footslope zone, which leads to the formation of **first-order streams** and as a result, to the development of **channel processes**.

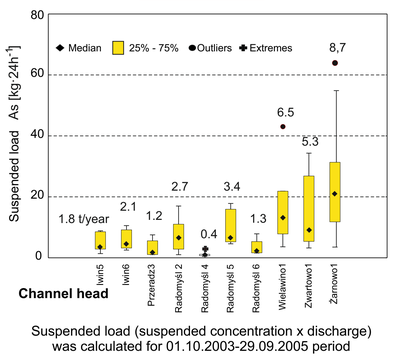



## ① SEDIMENT SOURCES




In the **channel heads**, zones of occurrence of the following processes were identified: (1) **seepage erosion**; (2) **falls, dry ravel events and slides**; (3) **creep, solifluction, surface runoff and erosion**; (4) **channel processes**; and (5) **landforms created under the impact of plants, animals and humans**. Most of the relief-forming processes in the channel heads are, or can be, generated with the contribution of groundwater outflows, and their intensity is controlled by external factors, e.g. the amount of atmospheric precipitation, the appearance of a snow cover and ground ice, the impact of the living activity of the biosphere, and also an increasing human interference. The mosaic of morphological processes in a headwater alcove is an effect of groundwater outflows occurring on its slopes and bottom, varying discharges of the outflows, and hydrostatic pressure - the driving force which makes groundwater flow out onto the land surface. The morphogenetic processes differ in their contribution to the supply of clastic material to the stream channel forming in the bottom of a given alcove, depending on the morphology of the alcove, lithology and mechanical properties of deposits, slope gradients, type of outflows, and water-flow conditions, but especially on their seasonal variations.

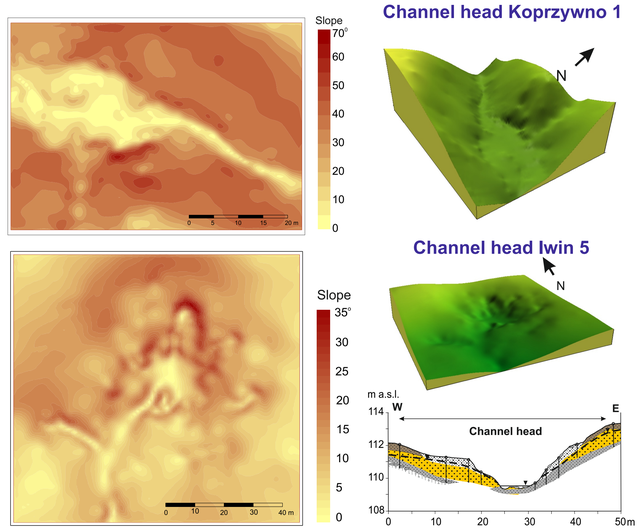


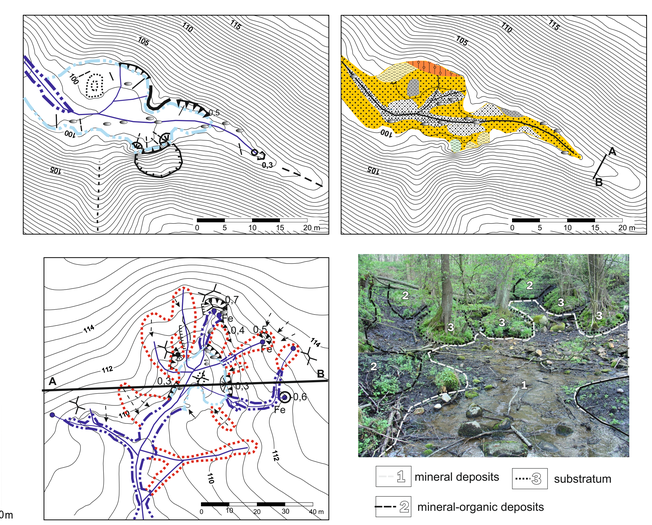

Suspended load (suspended concentration x discharge) was calculated for 01.10.2003-29.09.2005 period

## RESULTS

## ② MORPHOMETRY




## ③ GEOMORPHOLOGY




## ④ LITHOLOGY




## LEGEND

Talus, fans · Erosional residuals · Stumps, trunks · Spring outflow · Runoff path · Borehole · Groundwater level · Channel outflows · Silty sand · Coarse sand · Medium sand with organic matter · Medium sand · Medium sand with gravels · Sandy till · Erosional pavement · Fe precipitation



## CONCLUSIONS

The co-occurrence of various denudational processes in the channel heads produces variations in the accumulation conditions, and as a result, a diversity of deposits. The mineral series includes erosional pavements, colluvium, and alluvial deposits. Changes in hydrodynamic conditions are favourable to organic accumulation (peats and organic-mineral silt) as well as chemical and biochemical deposition (calcareous tufa and precipitation of Fe-oxides). Seepage channels grow when they attract enough groundwater to remove clastic material from the heads. Depending on the discharge volume of the outflow from the ten observed spring-formed alcoves (1-73 L/s), products of mechanical denudation (4-54 mg/L) are transported from the slope system to the fluvial system. The morphometry of the spring-formed alcoves as well as deposits found in them reflect stages of their development. Changes in the development of the channel heads occur as a result of variations in the groundwater table that are due to changes in climatic conditions or land use.