**Marie Skłodowska-Curie**

**Innovative Training Network**

**“HypoTRAIN”**

**Hyporheic Zone Processes – A training network for enhancing the understanding of complex physical, chemical and biological process interactions**

*Grant Agreement No. 641939*

# Deliverable D5.4

## Improved conceptual model of HZ processes

**Dissemination Level of Deliverable:**

| | | |
|---|---|---|
| **PU** | Public | **X** |
| **CO** | Confidential, only for the members of the consortium (including the Commission Services) | |

## Improved conceptual model of HZ processes

HypoTRAIN is dedicated to improve knowledge and understanding of physical, chemical and biological processes in the hyporheic zone which contribute to rivers' self-cleaning capacities. By the end of the project the HypoTRAIN team can proudly look back on a number of results and publications which sum up to a completed conceptual model of the interacting processes:

Processes in the hyporheic zone are controlled by five main drivers which vary in time and space (Magliozzi et al. 2018): (1) topology, (2.) human activities, (3.) ecology, (4.) hydrology and (5.) hydrogeology. To add to this complexity, these drivers are interdependent and can have antagonistic or synergistic interactions with each other. The boxes on the diagram in the attachment present examples of state-of-the-art improved understanding of key processes through collaborative interdisciplinary research carried out as part of HypoTrain.

1. Driver: Topology – The morphology of the streambed plays a crucial role in driving hyporheic exchange. Steeper terrain offers larger potential for increased hyporheic exchange, however this will depend on interactions with site-specific hydrological and hydrogeological conditions (b). Read more: Betterle et al. 2017; Babak Mojarrad et al. 2017; Mojarrad, Wörman, and Riml 2016

2. Driver: Human activities – Anthropogenic activities impact all other drivers. Activities such as damming, impact flow regimes and the transfer of nutrients and heat to ecological communities. Canalization and landscaping impact topography and hydrological conditions. Groundwater extraction (e.g. for drinking water production) can alter regional hydrogeological conditions. In addition, release of treated wastewater, recreational activities and urban areas introduce micropollutants to lotic systems and make alternative nutrients loads available to microbial communities. Read more: Posselt et al. 2018; Jaeger et al. 2017

3. Driver: Ecology – Responsible for much of the actual transformation of many micropollutants. Prevailing environmental conditions such as temperature, dissolved organic carbon content, or type and size of the sediment matrix will determine which functional communities will be present and their ability/rate to transform micropollutants. Site specific hydrogeological conditions will determine residence times of water passing through the hyporheic zone and thus impact the efficacy of transformation processes. Read more: Peralta-Maraver, Reiss, and Robertson 2018; Njeru, Posselt, and Horn 2017; Peralta-Maraver et al. 2018; Mechelke et al. 2017

4. Driver: Hydrology – At reach-scale exchange of surface water to sediments is driven by pressure gradients caused by water flowing over streambed structures. Streambed bathymetry, and the presence of obstacles such as woody debris can enhance or suppress hyporheic exchange. Together with large scale hydrogeological conditions these factors dictate the

quantity of hyporheic exchange and determine residence times of water within the hyporheic zone. Read more: Galloway et al. 2017; Popp and Kipfer 2018

5. Driver: Hydrogeology – Regional hydraulic gradients (h) and the bedrock material dictate catchment-scale patterns of hyporheic exchange. Hydrogeological conditions will also determine the sediment grain size and streambed roughness and thus interact with ecology and hydrology.

The attachment of this deliverable summarizes the current picture of processes in hyporheic zones and indicates where HypoTRAIN contributed knowledge for improved understanding.

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## Conceptual diagram of Hyporheic Zone Processes

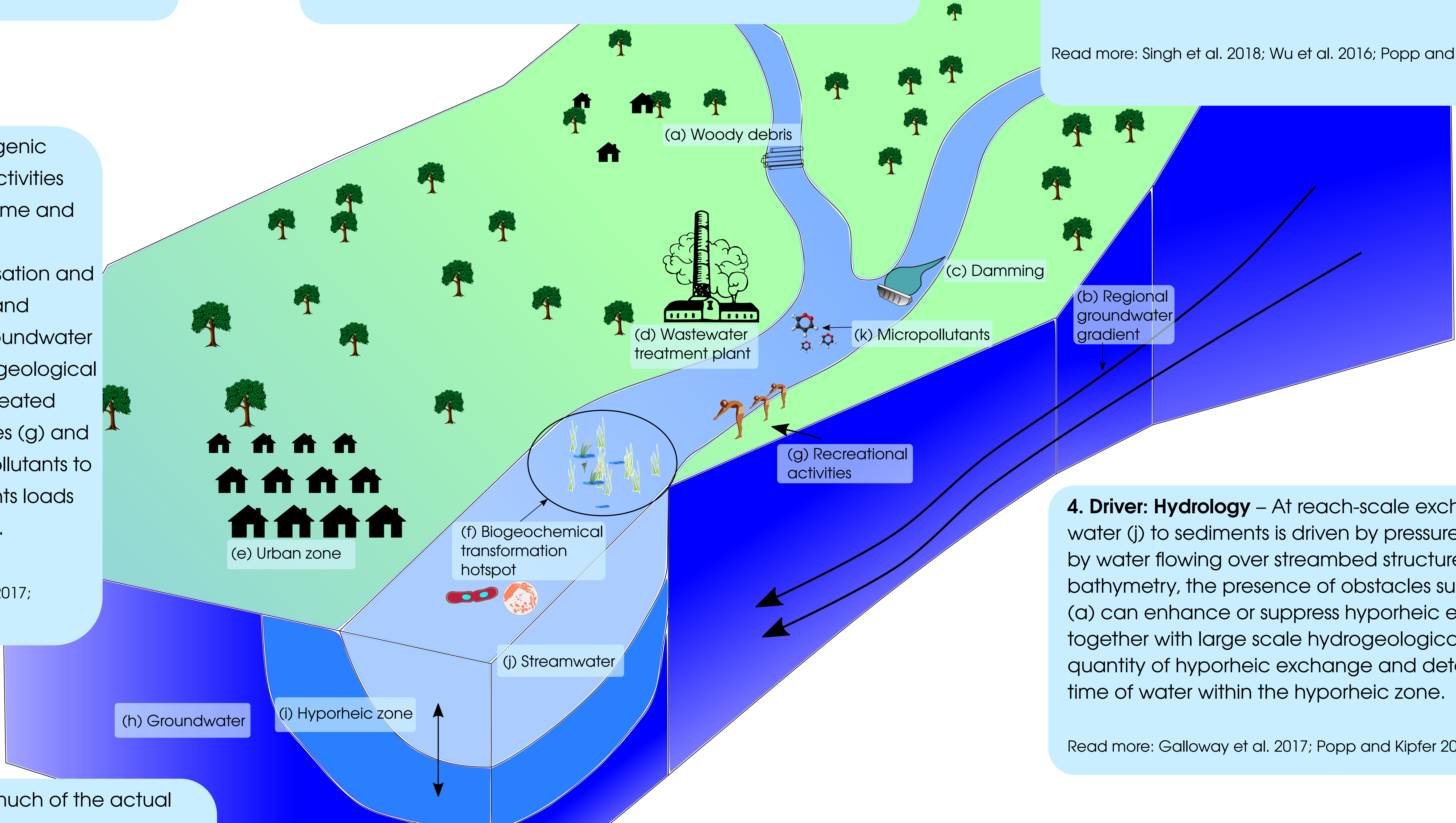
There are five main drivers which vary in time and space (Magliozzi et al. 2018): topology (1.), anthropology (2.), ecology (3.), hydrology (4.) and hydrogeology (5.). To add to this complexity, these drivers are interdependent and can have antagonistic or synergistic interactions with each other. The boxes on this diagram present examples of state-of-the-art improved understanding of key processes through collaborative interdisciplinary research carried out as part of HypoTrain.

**1. Driver: Topology** – The morphology of the streambed plays a crucial role in driving hyporheic exchange. With steeper terrain offering the potential for increased hyporheic exchange. However this will depend on interactions with site specific hydrological and hydrogeological conditions (b).

Read more: Betterle et al. 2017; Babak Mojarrad et al. 2017; Mojarrad, Wörman, and Riml 2016

**2. Driver: Anthropology** – Anthropogenic activities impact all other drivers. Activities such damming (c) impact flow regime and the transfer of nutrients and heat to ecological communities (f). Canalisation and landscaping impacts topography and hydrological conditions (b) and groundwater extracting can alter regional hydrogeological conditions. In addition, release of treated wastewater (d), recreational activies (g) and urban areas (e) introduces micropollutants to lotic systems and alternative nutrients loads available to microbial communities.

Read more: Posselt et al. 2018; Jaeger et al. 2017; Mechelke et al. 2018




**5. Driver: Hydrogeology** – Regional hydraulic gradients (b) and the bedrock material dictate catchment-scale patterns of hyporheic exchange. Hydrogeological conditions will also determine the sediment grain size and streambed roughness and thus interact with ecology and hydrology.

Read more: Singh et al. 2018; Wu et al. 2016; Popp and Kipfer 2017

**4. Driver: Hydrology** – At reach-scale exchange of surface water (j) to sediments is driven by pressure gradients caused by water flowing over streambed structures. Streambed bathymetry, the presence of obstacles such as woody debris (a) can enhance or suppress hyporheic exchange (i) and together with large scale hydrogeological will dictate the quantity of hyporheic exchange and determine residence time of water within the hyporheic zone.

Read more: Galloway et al. 2017; Popp and Kipfer 2018

**3. Driver: Ecology** – Responsible for much of the actual transformation (f) of many micropollutants (k). Prevailing environmental conditions such as temperature, dissolved organic carbon content, type and size of sediment matrix will determine which functional communities will be present and their ability/rate to transform micropollutants. Site specific hydrological conditions will determine residence times of water passing through the hyporheic zone and thus the impact the efficacy of transformation processes.

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