Unsolved Problems in Hydrology (UPH)
Outcomes of the plenary voting at the VCSS on 14 April 2018

Floods and droughts	Gold	Silver	Out
How to reconstruct paleohydrological phenomena during the Holocene and why did they happen?		x	
How do geomorphic processes interact with floods and droughts?	x		
What limits our abilities to forecast floods and droughts at different lead time lengths?			x
To what extent can nature-based solutions reduce flood risk and drought risks and increase the resilience of water resources? – make more precise			x
Why do drought and flood rich/poor periods exist?	x		
How do extreme floods and droughts around the world teleconnect with each other and with other factors?		x	
Are the characteristics of extreme events changing and if so why?	x		
What is the role of changing land use/land cover change patterns on in-situ and downwind droughts and floods? Why are some catchments more sensitive to land-use/cover change than others? – reword	x		
Hydrological change (water balance)			
How do we adapt hydrological models to be able to extrapolate to changed conditions.	x		
Can we identify tipping points of hydrological systems due to changes in climate and/or human impacts.	x		
Is the hydrological cycle regionally accelerating/decelerating under global warming?	x		
Why do we see long term cycles and correlations in hydroclimatological variables? What is the cause of the Hurst phenomenon? – combine	x		
How strong is the impact of hydrological change on the migration of people worldwide and what is the effect of migration on hydrologic change? – need external research expertise		x	
What is the role of water in the collapse of ancient civilizations and the implications for contemporary water management? – need external research expertise for wording		x	
What is the hydrologic effect of thawing permafrost		x	
Snow and ice			
Why do changes in the snow fall regime have a very different impact on stream flow in different catchments?		x	
What are the controls on and consequences of (e.g. streamflow, groundwater recharge, evaporation, soil moisture etc.) the spatial and temporal patterns of snow and ice in catchments?	x		
Why and when do rain-on-snow events produce exceptional runoff?		x	
When will we run out of glacier augmentation (to runoff and groundwater) and what will happen to those catchments? (until and after)		x	
Evaporation and precipitation			
Why are evapotranspiration rates spatially homogeneous despite		x	

differences in controlling mechanisms?			
Why is aridity (according to the Budyko Curve) the main controlling factor in the partitioning between runoff and evapotranspiration?		x	
What is the fate and lifetime of evaporated water from land surfaces?		x	
Landscape processes and streamflow			
Why is stream water so young when ground water is so old?		x	
Why is most flow preferential and what are the consequences?	x		
Why is the connectivity between hillslopes and streams so heterogeneous and dynamic?	x		
Why do streams respond so quickly to rainfall, with storm flow that is so old?		x	
Scale and scaling			
Why do dominant hydrological processes emerge and disappear across scales? Why is hydrology simple at the catchment scale despite being complex at smaller scales?	x		
Under what conditions can we substitute space for time in hydrology?		x	
How do constitutive relationships and their parameters change with scale?		x	
What are the emergent hydrological “laws” at catchment scale?		x	
Modelling (general)			
How can we identify the similarities between catchments?		x	
What is the sensitivity of hydrologic models to vegetation dynamics?		x	
How to disentangle and reduce model structural/parameter/input uncertainty in hydrological prediction?		x	
What do we have to do to build a unified hydrological model?			x
How can theories and methodologies be developed to reduce equifinality?			x
How to integrate citizen science and data for the understanding and mitigation of the effects of natural disasters by risk awareness, communication and outreach activities?			x
How important is hydrology in controlling bio/geo/chemical cycles and ecology?			x
Measurements and data			
How can we accurately measure subsurface properties, states and fluxes at a range of scales in space and time?	x		
How to reduce uncertainty in large-scale hydrological fluxes using novel technologies/remote sensing?		x	
What are the consequences of choosing between a large number of less accurate observations vs a few more accurate measurements?		x	
How to extract information from available data on human and water systems in order to inform the building process of socio-hydrological models?		x	
How can we convincingly put a value to hydrological observation systems with open data to reverse the current trend of decline of observation systems?		x	
Water quality			
What are the dominant processes controlling the fate of material	x		

fluxes in catchments over different spatial and temporal scales?			
Why are reaction coefficients for the same process heterogeneous in time and in space across different soils, streams, lakes, catchments, groundwater bodies…?		x	
How does water quality influence human-water interactions?			x
What factors contribute to the persistence of sources affecting water-quality?			x
Groundwater and soils			
What are the impacts of climate and environmental change on aquifer recharge?	x		
What are the processes in the unsaturated zone, which have significant impacts on groundwater recharge and composition?		x	
What are the storages and fluxes of groundwater across boundaries (oceans, atmosphere and inter-catchment fluxes) at different scales?	x		
Why is soil-water content so variable in space and time?		x	
How can we precisely define groundwater pathways in karstic and fractured aquifers?			x
How can we upscale Richard's equation to the catchment scale?			x
How important is groundwater to aquatic and terrestrial surface biodiversity, and vice-versa?			x
What are the effects of natural and anthropogenic soil disturbances on heat and mass fluxes at the land-atmosphere interface?		x	
What are the processes of groundwater-surface water interactions, including the role of the hyporheic zone (e.g. in contaminant fate and transport), and the dependencies of different ecosystems?		x	
Why are microbial pathogens removed or inactivated in the subsurface?			x
Communicating and engineering in hydrology			
How to communicate (un)certainty to decision makers and general public		x	
How can we shift the culture among hydrological science to encourage collaboration with industry and stakeholders across disciplines, and improve evidence-based decision making?			x
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