**Nomination Form of Candidate for the International Qian Ning Prize**

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| Name | **Marwan Hassan** | | Sex | M |
| Nationality | **Canadian** | Date of birth | **Dec. 31, 1958** | |
| Affiliation | **The University of British Columbia** | | | |
| Professional Position | **Professor and Head** | | | |
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## 1. RESUME

### (1) Education:

PhD 1984-1989 Institute of Earth Sciences, Hebrew University of Jerusalem
MSc 1983-1984 Institute of Earth Sciences, Hebrew University of Jerusalem
BA 1978-1982 Department of Geography, Ben-Gurion University

### (2) Professional Positions:

Head of Department 2012-present
Professor 2009-present Department of Geography, UBC
Associate Professor 2006-2009 Department of geography, UBC
Assistant Professor 2004-2006 Department of Geography, UBC
Adjunct Professor 2001-2004 Department of Geography, UBC
Senior Lecturer 1996-2002 Department of Geography, Hebrew University
Lecturer 1994-1996 Department of Geography, Glasgow University
Research Fellow 1991-1994 Department of Geography, UBC
Postdoc Fellow 1989-1991 Department of Geography, UBC
Postdoc Fellow 1988-1988 Department of Geography, Birkbeck Collage, London
Postdoc Fellow 1988-1988 Department of Geography, University of St. Andrews, UK
Teaching Assistant 1982-1998 Department of Geography, Hebrew University

### (3) Involvement in International and National Scientific Activities:

**AGU, EGU, CGU, IAHS, Gravel-bed Rivers**

### (4) Research interests:

Fluvial Geomorphology, Erosion, transport and deposition of fluvial sediments, landscape evolution, ecogeomorphology, ecohydrology, arid lands hydrology, urban hydrology, water

resources, river restoration

## (5) Selected Publications:

### Published more than 150 reviewed publications


Hassan, M.A., Bird, S., Reid, D., Ferrer-Boix, C., Hogan, D., Brardinoni, F., and Chartrand, S. (2018). Variable hillslope-channel coupling and channel characteristics of forested mountain streams in glaciated landscapes. Earth Surface Processes and Landforms, DOI: 10.1002/esp.4527.

Hassan, M. A., L. Roberge, M. Church, M. More, S. D. Donner, J. Leach, and K. F. Ali (2017), What are the contemporary sources of sediment in the Mississippi River?, Geophys. Res. Lett., 44, doi:10.1002/2017GL074046.

Hassan, M. A., D. Brayshaw, Y. Alila, and E. Andrews, 2014. Effective discharge in small formerly glaciated mountain streams of British Columbia: Limitations and implications, Water Resources Research, 50, 4440–4458, doi:10.1002/2013WR014529.

Hassan, M. A., H. Voepel, R. Schumer, G. Parker, and L. Fraccarollo (2013), Displacement characteristics of coarse fluvial bed sediment, J. Geophys. Res. Earth Surf., 118, doi:10.1029/2012JF002374.

Hassan, M.A., A.S. Gottesfeld, D.R. Montgomery, J.F. Tunnicliffe, G.K.C. Clarke, G. Wynn, H. Jones-Cox, R. Poirier, E. MacIsaac, H. Herunter, and S.J. Mcdonald, 2008. Salmon-driven bedload transport and bed morphology in mountain streams, *Geophysical Research Letters*, Volume 35, L04405, doi:10.1029/2007GL032997.

Hassan, M.A., M. Church, X. Xu and Y. Yan, 2008. Spatial and temporal variation of sediment yield in the landscape: the example of Huanghe (Yellow River), *Geophysical Research Letters*, 35, L06401, doi:10.1029/2008GL033428.

Hassan, M.A., R. Egozi and G. Parker, 2006. Effect of hydrograph characteristics on vertical sorting in gravel-bed rivers: humid versus arid environments, *Water Resources Research*, 42, W09408, doi:10.1029/2005WR004707.

Hassan, M.A. and M. Church, 2000. Experiments on surface structure and partial sediment transport, *Water Resources Research*, 36, 1885-1895.

Hassan, M.A. and M. Church, 1994. Vertical mixing of coarse particles in gravel bed rivers: a kinematic model, *Water Resources Research*, 30, 1173-1185.

Hassan, M.A., M. Church and A.P. Schick, 1991. Distance of movement of coarse particles in a gravel bed stream, *Water Resources Research*, 27, 503-511.


## (6) Academic Achievements and Awards:

Distinguished Visiting Professor, Dept. of Hydraulic Engineering, Tsinghua University, China—2017-2020

Senior Early Career Scholar, Peter Wall Institute for Advanced Studies, The University of British Columbia, 2007-2008.

Three-year Fellowship from the Israel Council of Higher Education (within the framework of a national competition between young scientists applying for university appointments in Israel), 1997-1999.

Izaak Walton Killam Memorial Post-doctoral Fellowship, University of British Columbia, 1989-1991.

Rothschild Post-doctoral Fellowship, Hebrew University of Jerusalem, 1988-1989.

British Council Fellowship, University of St. Andrews, St. Andrews, UK, 1988.

British Council Fellowship, University of London, London, 1988.

The Israeli Prime Minister's Award for Outstanding Students, 1985.

The Goldschmidt Annual Award for Young Researchers in Hydrology, Israel Hydrological Association, 1984.

## 2. Three most outstanding achievements with supporting materials

Dr. Hassan is an internationally recognized fluvial geomorphologist who works on sediment transport, channel stability, channel morphology, sediment yield and stream ecology in a wide range of environments. Impressively, his 30-year research career has provided fundamental scientific contributions based on a combination of field studies, laboratory and physical experiments, numerical model development and creation and implementation of new research methodologies and instrumentation. In particular, Dr. Hassan has made leading contributions to three distinct aspects of the geophysical sciences related to sediment transport and geomorphology: sediment transport and channel morphology, watershed geomorphology and landscape evolution. Dr. Hassan's PhD work provides the first known field test of the basic concepts laid out in Einstein's probabilistic theory of granular transport in rivers. This work gave Dr. Hassan a firm foothold in sediment transport mechanics and theory, which he leveraged and applied at the local and drainage basin scales. At the local scale of a river, he demonstrated that organized arrangements of sediment particles on the bed surface provide a measurable component of resistance to bed surface rearrangement, or complete

change, and that the shape of flood hydrographs mediates the development of resistance. He also is thought to be the first to illustrate that spawning salmonids can measurably affect the local annual bedload sediment budget of gravel-bed streams, leading the way for the development of the field ecogeomorphology. At the drainage basin scale, he has illustrated how human actions to the landscape, a hallmark of the Anthropocene, couple to and set the trajectory of sediment connectivity and routing within the large, heavily modified river basins of the Mississippi and Huanghe (Yellow River), as well as within smaller basins in Israel. Finally, Dr. Hassan combined the local and watershed scale perspectives to elucidate the legacy effects of glaciation on fluvial landscape evolution, challenging existing paradigms and demonstrating a clear connection between climate and landscape-scale processes.

Beginning with his PhD work, Dr. Hassan focused on developing field strategies to track and quantify the movements of discrete sediment particles within arid basin rivers. An outcome of this work was the development of a tracking technique which used the magnetic signature carried by different sediment particles detect the passage of grains past a monitoring location. The development of this technique enabled Dr. Hassan to follow and recover suitably large samples of sediment particles to further examine core concepts of Einstein's probabilistic theory of sediment transport. Specifically, the data allowed him to describe and quantify the step length and burial depth of discrete sediment particles in gravel-bed rivers. Both the tracing technique and his analytical methods have become standards in the literature. Empirical observations of how far sediment particles move when set in motion by flood conditions have yielded two correlations of practical value, and both relations have been extensively used by the research community to estimate sediment transport in gravel-bed rivers. His pioneering work observing and quantifying sediment particle motions motivated development of one- and two-dimensional models that simulate the movement of individual stones. These contributions have been and continue to be critical to the trajectory of basic sediment transport research, in part motivating the ongoing development of a re-envisioned transport theory based within stochastic science and statistical mechanics. On this basis alone, Dr. Hassan's work rises to the merits of the Qian Ning prize.

Dr. Hassan has completed several major studies of sediment transport and channel stability in upland gravel bed streams, which combined fieldwork, flume experiments and numerical simulations. The focus of the work was to examine the role of bed surface particle structures in mediating channel evolution or change, and how the shape of hydrographs effects the influence and development of particle structures. Basic results from the field component of the work have identified a clear stabilizing role of sediment particle structures for river beds, detected in part through differences in the rates of sediment transport with and without particle structures. This outcome motivated experimental testing of the full/partial mobility theory of riverine sediment transport, and further quantification of the impact of bed surface structures on sediment transport and channel stability. Flume experiments cover a wide range of flow regimes, and surprisingly showed that bed sediment transport in upland streams commonly occurs at near-threshold transport

rates. This finding challenged the engineering-based convention that sediment transport is constrained to and "on" or "off" condition, or the assumption of full sediment mobility. Indeed, his work has shown that partial sediment mobility is an important condition of mountain stream mass transport, which occurs a majority of the time during any given observation period. His work using numerical simulations permitted a further elaboration and refinement of the role of hydrograph shape on the development of bed surface particle structures and armouring. This work shows that hydrograph shape and duration have a strong control on development of mountain river bed surfaces, which has implications for scheduled water releases from upland Dams, or how land development practice in both rural and urban settings influences flood event hydrograph modification.

Dr. Hassan has examined the pattern of areal sediment yield at the drainage basin scale within Israel, Canada, China and the United States. For the Israel study, Dr. Hassan initiated a project focusing on the impact of land use on sediment sources and sediment production in two small semi-arid drainage basins. The work in Canada has spanned several different basins, with an emphasis on examining how spatial patterns of hillslope-river connectivity affect sediment transport and storage. His work on the Huanghe (Yellow River) critically demonstrates the efficacy and overall impact of certain land use practice and management on basin-scale sediment yield, a major factor for large river navigability, flood risk, habitability and agricultural sustainability. His Huanghe work was highlighted by the American Geophysical Union Editorial Board, and a summary of the paper was distributed to the media. Last, and applying his insight and style of analysis from the Huanghe work to the Mississippi River, Dr. Hassan provides a basin-scale estimate of contemporary sediment sources within the basin. Results indicate that prior to implementation of landscape-scale soil management practices, most sediment in the Mississippi basin was sourced from upland erosion, transported downstream to fill valleys and rivers. After soil management practices were implemented, sediment sourcing switched to surface erosion of arable land, plus bank and riverbed erosion. Among other contributions, the Mississippi work challenges the use of common metrics that attempt to quantify the resilience of arable land to erosion, and calls for a re-evaluation of how such metrics are devised and utilized for decision making purposes.

Basic concepts of fluvial landscape organization conceptualize a systematic change of riverbed slope with drainage area, yielding so called "slope-area" or "process-domain" regime diagrams. Dr. Hassan pioneered research investigating how mountain drainage basin evolution in glaciated environments compare and contrast against the prevailing "process-domain" theories. His work demonstrated the fundamental control which large-scale climatic-driven events like glaciations have on fluvial landscape evolution and expression. Specifically, formerly glaciated basins exhibit "process-domain" structure which breaks from the systematics of non-glaciated "process-domains". River-bed slope does not vary in a systematic fashion with increasing drainage area. Instead, glaciation resets landscape and valley structure, which is inherited by contemporary river systems, setting the overall pattern and distribution of land steepness, which rivers evolve within, but have yet

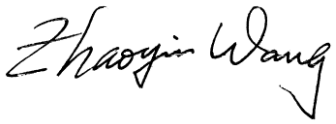
to fundamentally change. This work highlights the intrinsic link between climate and fluvial landscape evolution, and that the history of climatic variation on the timescale of 100,000 to 1,000,000 years can govern how landscapes evolve and self-organize.

In addition to Dr. Hassan's basic scientific contributions, he has established a long-term sediment transport monitoring station on East Creek, B.C., Canada to examine the impact of sediment supply/storage, bed surface structure and channel morphology on channel stability in small streams. The continuous monitoring system, which is unique in the world, is also the most extensive in Canada (e.g. multiple sediment traps, particle tracers, magnetic particle tracking system, surface texture and structures, photogrammetry, channel surveys and flow measurements) and is essential to understanding physical processes and designing and calibrating numerical models. Dr. Hassan was also solely responsible for the visioning, funding and construction of the Mountain Channel Hydraulic Experimental Laboratory at the University of British Columiba [as well as a similar facility at the Hebrew University], the largest fluvial experimental facility in Canada. The laboratory hosts two flumes, one stream table, one delta table, and a full sediment processing facility. Establishment of these facilities has helped to power Dr. Hassan's career, which over the last roughly 30 years, has garnered over 150 research manuscripts and book chapters. He is also a strong mentor and teacher, graduating a combined total 40 Masters and PhD students. He has worldwide collaborations with researchers on 4 of the 6 continents, and regularly works with disadvantaged communities in order to help create opportunities, and promote the work of under-represented scientists.

## 3. Recommendation reasons

- First geophysical scientist to develop of field-based test of Einstein's probabilistic theory of sediment transport, providing evidence that sediment particles originating from similar locations can undergo radically different transport histories;
- First geophysical scientist to demonstrate a cause-effect link between spawning salmonids and the annual bedload sediment budget of river reach, paving the way for the growth and development of the field of ecogeomorphology;
- At the forefront of basic sediment transport research, both in building research methodologies still in use today, and methodically devising and executing field-based, laboratory and numerical based studies of the controls of coarse and fine grained sediment transport in mountain and lowland rivers;
- At the forefront in establishing clear links between rivers and landscapes through his demonstration of a measurable effect of land use practice on rates of landscape-scale sediment supply in two of the largest river basins on the planet, the Huanghe and the Mississippi;
- At the forefront in demonstrating the lasting effects of glaciation on fluvial landscape evolution, leading to an overall broadened understanding of landscape dynamics and

variability;



Signature:

Date: March 29, 2019

**4. Preliminary screening** (to be filled by the Office)