

Proposal for the creation at UNESCO-IHP of the  
**“Land Subsidence International Initiative (LaSII)”**

## **Background**

Land Subsidence (LS), i.e., the loss of land elevation, is a major problem that threatens viability and sustainable economic development for many millions of people throughout the world, especially, but not restricted to coastal and highly urbanized areas.

The UNESCO Working Group on Land Subsidence (WGSL) is one of the oldest working groups within the International Hydrological Programme (IHP), initiating activities during the 1965-1974 International Hydrological Decade (IHD). In the 1970s the WGSL started its activities to improve and disseminate knowledge on LS, mainly in developed and newly-developed countries and regions, e.g., Japan, The Netherlands, USA, Italy, Mexico, China, Taiwan that were strongly affected by LS following the economic boom after the World Wars. Since 2010 the members of the WGSL established new linkages and collaborations with other international and national hydrologic programs and projects concerned with the sustainable development of global land and freshwater resources and the subsidence hazards accompanying their exploitation, mainly in developing countries such as Indonesia, Pakistan, Egypt, Vietnam, India, Iran, etc. Now, facing global changes, the need to disseminate this knowledge more broadly and to intensify applications of the accumulated knowledge is urgent.

In the IHP-VIII Phase Strategic Plan (2014-2021) which addresses Water Security, LS is considered as a major threat. Because of the strong anthropogenic component of the prevalent subsidence processes, the activities of the LaSII would be aligned implicitly with groundwater withdrawal and aspects related with hydro hazards (risk management related to global changes, human and natural processes and observation systems); groundwater in a changing environment (sustainable groundwater management and impacts of climate changes on aquifer systems); water scarcity (efficient use of water resources and the improvement of legal and policy capacities) and, engineering harmony to face increasing climate instability and demographic growth.

### Why Land Subsidence (LS) is still a critical societal issue

Society is facing a large number of challenges related to the sustainable use of land and water resources that will increase in the next decades. The effects of climate change in terms of sea-level rise and variation in the distribution and timing of precipitation, runoff and recharge, are compounded by the increasing concentration of population in (mega-) cities and elsewhere along the coasts of the world. The consequences related to the expanding need of freshwater resources in even more concentrated, at-risk zones of the world will inevitably affect a growing number of people.

A few worldwide case studies clarify the present criticality of the LS due to aquifer over-exploitation: 1) in Jakarta, Indonesia, where the population grew from 8.2 million to more than 30 million from 1970 to 2016, groundwater extraction has caused the sinking of land surface at rates of 10-20 cm/yr, with a dramatic increase of vulnerability to flooding from river and sea waters; 2) in many deltaic and coastal areas of the world (e.g., the Bengal, Mekong, Nile, and Mississippi river deltas) LS occurs as a result of compaction and oxidation increasing CO<sub>2</sub> emissions to the atmosphere, losing valuable ecosystems, and enhancing the vulnerability to coastal and riverine flooding; 3) in numerous regions (e.g., China, Mexico, Arizona, Iran, Pakistan) in the world large ground fractures occur as a result of LS with damages to structures/infrastructures and increased aquifer contamination favored by rapid infiltration of wastewaters and pollutants through the fissures; 4) in Mexico City many buildings and houses were severely damaged during the September 19<sup>th</sup>, 2017 earthquake in areas

where the subsoil was strongly weakened by ground fractures that previously developed with the more than 10 m of LS accompanying groundwater exploitation.

Despite the facts that the scientific basis of aquifer-system compaction and LS due to groundwater pumping, and the means to mitigate its occurrence are well known, the process is increasingly affecting more and larger regions and with greater consequences throughout the world. In the IHP-VIII Phase Strategic Plan which addresses Water Security, LS is considered as a major threat.

Nevertheless, the attention afforded by LS in sustainable planning of water services and safe urban development is still undervalued. Although difficult to quantify, the direct and indirect costs associated to damages caused by LS are extremely large. Here a few examples: 2500 M€/year in China; 1092 M€ (1300 M\$) from 1955 to 1972 in the San Joaquin Valley, USA; 360 M€/year in Poland; 50 M€ from 1992 to 1995 in Murcia City, Spain; 52 B€/year in The Netherlands (the national planning bureau PBL, Netherlands Environmental Assessment Agency calculated that in the Netherlands, the cost for society of land subsidence occurring in peatlands amounts to billions of Euros). Furthermore, the consequences are expected to increase in the next decades.

### **WGLS role in the development of an IHP-UNESCO Land Subsidence International Initiative (LaSII)**

Until now, a still growing group of scientists from all over the world have – on a voluntary basis – joined in the WGLS. They are willing to share their knowledge, mainly collected through individual research projects, and enhance subsidence awareness.

As a LaSII the group of experts and collaborators will seek stronger support from the UNESCO IHP and the governments of the 11 countries that are now participating (see detailed list of Members at the end of the document), to consolidate the development of methodologies for characterization and modeling of LS, monitoring networks, transfer of information to decision makers, advise creation of public policies and ideally, in the end contribute to an increase in the security and resilience of inhabitants of LS affected areas. Moreover, there is an urgent need to transfer the generated knowledge to developing countries with limited access to research studies and monitoring. The main goals are to improve access to scientists and engineers from developing countries, enhance knowledge transfer and achieve a better planning for the sustainable use of the groundwater resources LS-affected regions in view of the expected climate changes.

### **Objectives and activities**

LaSII will focus primarily on four main aspects:

1. LS due to groundwater resources overexploitation,
2. LS in coastal areas, related with sea-level rise,
3. LS related with earth fissures, ground fractures and fault reactivation,
4. LS related with water security in urban areas.

The main goals to achieve with the creation of LaSII are:

- to propose effective methodologies for LS identifying and establishing an inventory of subsiding areas in the world;
- to publish guidelines for the identification, investigation, development and management of LS-related phenomena to be used in emergencies;
- to support capacity building in member countries in order to gain and advocate better understanding and handling of hazards, vulnerabilities and benefits involving LS and other groundwater-related disasters;

- to raise awareness of decision makers, implementers, users and the general public of the importance of groundwater as a store of freshwater in order to encourage improved protection and sustainable exploitation of groundwater - through leaflets, publications, the media, education and training;
- strengthen capacity building and educational capabilities in urban water management aimed at relevant target groups, including decision makers, planners and practitioners, with a special emphasis on developing countries;
- to facilitate participation of IHP Focal Points and National Committees in the development of case studies and the dissemination of LS mitigation guidelines;
- strengthen linkages with other IHP Programs: ICHARM (International Centre for water Hazard And Risk Management), FRIEND (Flow Regimes from International Experimental and Network Data), HELP (Hydrology for the Environment, Life and Policy), and Urban Water Management (UWMP) together with international institutions (i.e. International Association of Hydrogeologists, International Society of Soils Mechanics and Geotechnical Engineering, Eurogeosurveys, etc.);
- to favor financial support from external sources, such as World Bank, UNDP, EU, national founding agencies.

#### Proposed activities of the LaSII:

- publishing a guidebook on land subsidence;
- convening annual WG meetings;
- organizing, sponsoring and convening a 5-yearly international symposium on land subsidence over five decades (the ninth held at Nagoya, Japan, in 2015 and the tenth will be held in The Netherlands in 2020);
- establishing a growing number of collaborations with other local, state and national subsidence-interest groups, and several collaborative projects;
- the improvement and regular updating of the WG website (<http://landsubsidence-unesco.org/>). It contains general informative material, a worldwide map of the land subsidence occurrences, the proceedings of the past nine symposiums on land subsidence, scientific articles and technical reports. Maps production could be undertaken in coordination with the UNESCO WHYMAP programme.

#### Implications of LaSII on the UNESCO-IHP Programme and Secretariat

Similar to what has been carried out by the WGLS until now (short summary of the activities carried out without any financial support from UNESCO listed at the end of the document), LaSII activities will not have direct financial implications for the IHP Secretariat, as it will rely entirely on extra budgetary.

The IHP support will mainly include provision of guidance on:

- the establishment of the Initiative;
- reporting the progress achieved by the Initiative to the sessions of the IHP Intergovernmental Council;
- sharing the main results of the Initiative with the UNESCO Water Family and beyond.

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- List of current members of WGLS
- Main activities carried out by WGLS (2010-2018)

## List of current members of WGLS

Name	Affiliation	Country	Role
Dora Carreon-Freyre	Universidad Nacional Autonoma de Mexico (UNAM)	Mexico	Chair
Pietro Teatini	University of Padova	Italy	Vice-Chair
John Lambert	Deltares	The Netherlands	Technical Secretary
Mahmoud Bakr	Dar Al-Handasah Consultants	Egypt	Member
Tom Burbey	Virginia Tech University	USA	Member
Enrique Cabral-Cano	UNAM	Mexico	Member
Kenji Daito	Daido University	Japan	Member
Ger de Lange	Deltares	The Netherlands	Member
Peter Fokker	TNO	The Netherlands	Member
Devin Galloway	USGS	USA	Member
Gerardo Herrera	Instituto Geológico y Minero de España	Spain	Member
Wei-Chia (Kelvin) Hung	Green Environmental Engineering Consultant Co. LTD	Taiwan	Member
Agnieszka Malinowska	AGH University of Science and Technology	Poland	Member
Michelle Sneed	USGS	USA	Member
Roberto Tomás Jover	University of Alicante	Spain	Member
Luigi Tosi	National Research Council	Italy	Observer
Najeeb Ullah	Balochistan Integrated Water Resouces Management & Development Project (The World Bank)	Pakistan	Observer
Hanmei Wang	Shanghai Institute of Geological Survey	P.R. China	Member
Shujun Ye	Nanjing University	P.R. China	Member
Hasanuddin Z. Abidin	Department of Geodetic Engineering Institute of Technology Bandung	Indonesia	Member

## Main activities carried out by WGLS (2010-2018)

- Organization of annual meetings with a specific agenda, mainly related with the integration of individual and group achievements such as the development of collaboration projects;
- Participation in local and international academic meetings;

- Collaboration for scientific papers, diffusion brochures, undergraduate and pos-graduate thesis, technical reports;
- Organization of technical and academic meetings, courses and fieldtrips in the country that host the annual meeting;
- Organization of the five yearly International Symposium;
- Collaboration for the exchange of analysis, methodologies and information.