Form V

United Nations
Educational, Scientific and
Cultural Organization

Annual Report* of IGCP Project No._641_

***NOTE: MAXIMUM LENGTH OF THE TEXT REPORT IS 5 (FIVE) PAGES (starting from question 1). SINGLE SPACE, 12 POINT FONT. REPORTS EXCEEDING THIS LENGTH WILL BE RETURNED TO THE AUTHOR(S) WITH THE REQUEST OF REDUCING THE TEXT TO THE ABOVE STANDARD.**

Send to UNESCO and IUGS
ml.faber@unesco.org
iugs.beijing@gmail.com
by 01/12/2015

A LIST OF PUBLICATIONS HAS TO BE ADDED AS AN ANNEX.

***REMINDER: IF THIS IS THE FINAL YEAR OF YOUR PROJECT, PLEASE SUBMIT A REVIEW ARTICLE ABOUT YOUR PROJECT TO THE IUGS JOURNAL '*EPISODES*'.**

The scientific information in this report will further be used for publication on the IGCP website hosted at UNESCO (please feel free to attach any additional information you may consider relevant to the assessment of your project).

IGCP project short title: Deformation and fissuring caused by exploitation of subsurface fluids

Duration: 4 years

Please tick this box if the report is for a Project on extended term (OET): ☐

Project leader(s):

1. Name: Dora Carreon-Freyre
   Address: UNAM, Bd. Juriquilla 3001. Querétaro, Qro. PC 76230, MEXICO
   Tel.: +52 442 238 1104 ext 112
   Fax: +52 442 238 1101
   Email: freyre@geociencias.unam.mx
2. Name: Devin Galloway
   Address: IWSC-USGS, 5957 Lakeside Blvd., Indianapolis, IN 46278, USA.
   Tel.: +1 916 801 2040
   Fax: +1 317 290 3313
   Email: dlgallow@usgs.gov
3. Name: Pietro Teatini
   Address: UP-CEAE. Via Trieste, 63, 35121 Padova, ITALY
   Tel.: +39 049 827 1330
   Fax: +39 104 8271333
   Email: pietro.teatini@dmsa.unipd.it

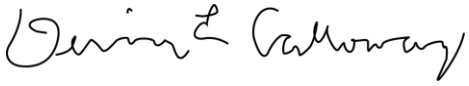
4. Name: Shujun Ye
Address: NU-Hydrosciences, Nanjing 210023, P. R. CHINA.
Tel.: +86 25 8968 4150
Fax: +86 25 8368 6016
Email: sjye@nju.edu.cn

Project Secretary:

Name: Carlos Hernandez Cabrera
Address: UNAM, Bd. Juriquilla 3001. Querétaro, Qro. PC 76230, MEXICO
Tel.: +52 442 238 1104 ext 174
Fax: +52 442 238 1101
Email: carlosh@geociencias.unam.mx

Date of submission of report: 15th December, 2015

Signature of project leader(s):

Leader	**Signature**
Dora Carreon-Freyre	
Devin Galloway	
Pietro Teatini	
Shujun Ye	

Form V

IGCP 641 M3EF3. Annual Report 2015

1. Website address(es) related to the project

http://igcp641.org

2. Summary of major past achievements of the project

N/A. This is the first year of the project, the leaders have been working together for more than 5 years organizing conferences, lectures, local projects and presentations.

3. Achievements of the project this year only

3.1. General scientific achievements
(Meetings are not considered as scientific achievements, they should be listed under heading 3.3.)

- Promoted integration, coordination and communication between scientists from different disciplines and countries by inviting experts to participate in knowledge exchange through the website (http://igcp641.org/participants/) and presentation of research in academic events. Forty-three participants from five countries are registered as participants of the project;
- Began development of a map of the global distribution of ground failure caused by subsurface fluid extraction by integrating reported study cases in the literature;
- Began characterization of the major ground-failure features in selected areas of Mexico City, Arizona and Nanjing (density, shape, length, aperture, depth, and dislocation);
- Integrated methodologies developed by each leader and project participants to investigate the generation/propagation of earth fissure and fault activation;
- Initiated establishment of a risk assessment procedure for determining the most probable conditions of ground failure.

3.2. List of IGCP project meetings/symposia and IGCP related meetings/symposia with exact attendance (if possible) and number of countries

- Special Session on Ground Fracturing during the Ninth International Symposium on Land Subsidence (NISOLS) organized by the UNESCO Working Group on Land Subsidence and the Daido University in Nagoya in Japan. November 2015.
  http://www.nisols2015.com

- Presentation of the project at the American Geophysical Union Fall meeting. December 2015. H51A-1342: Mechanisms, Monitoring and Modeling Earth Fissure generation and Fault activation due to subsurface Fluid exploitation (M3EF3): A UNESCO-IGCP project in partnership with the UNESCO-IHP Working Group on Land Subsidence, by Pietro Teatini, Dora Carreón-Freyre, Devin L. Galloway and Shujun Ye.
  https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/65232.

3.3. Educational, training or capacity building activities related to the IGCP project and IGCP project participants.

First Workshop held by the University of Nanjing with the participation of all the leaders of the project and invited specialists from China, Italy and Mexico.

3.4. List of countries involved in the project:
Mexico, United States of America, Italy, Spain and People's Republic of China (PRC)

3.5. Participation of scientists from developing countries, and in particular young and women scientists: exact number and please describe how this project specifically benefited women scientists, young scientists and/or scientists from developing countries

First Workshop Nanjing University	*Total number of scientists*	*Number of male scientists*	*Number of female scientists*
Number of participating scientists	*17*	*10*	*7*
Number of young scientists/students (<35 years old)	*10*	*6*	*4*
Number of scientists from developing countries	*6*	*4*	*2*

3.6. List of the 5 most important publications (including maps) of this year
a) could not have been published were if not for this project
b) related to this project

- **Carreon-Freyre, D.**; Cerca, M.; Ochoa-Gonzalez, G.; **Teatini, P.**; Zuñiga, R. Shearing along faults and stratigraphic joints controlled by land subsidence in the Valley of Queretaro, Mexico. **Galloway, D.**, Editor. Special issue on Land Subsidence, Hydrogeology Journal, Springer. Accepted for publication.
- **Ye,S.J**., Xue, Y.Q., Wu, J.C., Yan, X.X., Yu, J., Progression and mitigation of land subsidence in China. **Galloway, D.**, Editor. Special issue on Land Subsidence, Hydrogeology Journal, Springer. Accepted for publication.
- Franceschini, M. Ferronato, C. Janna, and **P. Teatini**, A novel Lagrangian approach for a stable numerical simulation of the mechanics of faults. Journal of Computational Physics. Submitted.

Full bibliography of this year (listed by author in alphabetical order with the most recent work listed first) has to be submitted as an annex. Distinguish between peer review literature and other (no abstracts).
a) could not have been published were if not for this project
b) related to this project

NISOLS Proceedings:

1. **Carreón-Freyre, D.**, Gonzalez-Hernandez, M., Martinez-Alfaro, D., Solis-Valdez, S., Vega-Gonzalez, M., Cerca, M., Millan-Malo, B., Gutierrez-Calderon, R., and Centeno-Salas, F., 2015. Analysis of the variation of the compressibility index (Cc) of volcanic clays and its application to estimate subsidence in lacustrine areas. Special Issue: Prevention and mitigation of natural and anthropogenic hazards due to land subsidence. Ninth International Symposium on Land Subsidence (NISOLS). Proc. IAHS, 372, 273–279, proc-iahs.net/372/273/2015/ doi:10.5194/piahs-372-273-2015.

2. Centeno-Salas, F., **Carreón-Freyre, D.**, Flores-Garcia, W., Gutierrez-Calderon, R. and Sanchez-Luna, E., 2015. Application of high resolution geophysical prospecting to assess the risk related to subsurface deformation in Mexico City. Special Issue: Prevention and mitigation of natural and anthropogenic hazards due to land subsidence. Ninth International Symposium on Land Subsidence (NISOLS). Proc. IAHS, 372, 267–272, proc-iahs.net/372/267/2015/ doi:10.5194/piahs-372-267-2015.
3. Franceschini, A., **Teatini, P.**, Janna, C., Ferronato, M., Gambolati, G., **Ye, S.** and **Carreon-Freyre, D.**, 2015. Modeling ground rupture due to groundwater withdrawal: applications to test cases in China and Mexico. Special Issue: Prevention and mitigation of natural and anthropogenic hazards due to land subsidence. Ninth International Symposium on Land Subsidence (NISOLS). Proc. IAHS, 372, 63–68, proc-iahs.net/372/63/2015/ doi:10.5194/piahs-372-63-2015.
4. **Ye, S**., Luo, Y., Wu, J., Teatini, P., Wang, H., Jiao, H., 2015. Three dimensional numerical modeling of land subsidence in Shangai. Special Issue: Prevention and mitigation of natural and anthropogenic hazards due to land subsidence. Ninth International Symposium on Land Subsidence (NISOLS). Proc. IAHS, 372, 443–448, proc-iahs.net/372/443/2015/ doi:10.5194/piahs-372-443-2015.
5. Cerca, M., Rocha, L., **Carreon-Freyre, D.**, Aranda, J., 2015. Physical experiments of land subsidence within a maar crater; insights for porosity variations and fracture localization. Special Issue: Prevention and mitigation of natural and anthropogenic hazards due to land subsidence. Ninth International Symposium on Land Subsidence (NISOLS). Proc. IAHS, 372, 285-290–448, proc-iahs.net/372/285/2015/ doi:10.5194/piahs-372-285-2015.
6. **Ye., S.**, Wang., Y., Wu, J., **Teatini, P.**, Yu, J., Gong, X., Wang, G., 2015. Characterization of eart fissures in South Jiangsu, China. Special Issue: Prevention and mitigproc-iahs.net/372/519/2015/ation of natural and anthropogenic hazards due to land subsidence. Ninth International Symposium on Land Subsidence (NISOLS). Proc. IAHS, 372, 249-253, proc-iahs.net/372/249/2015/ doi:10.5194/piahs-372-249-2015.
7. Gonzalez-Hernandez, M., **Carreón-Freyre, D.**, Gutierrez-Calderon, R., Cerca, M. and Flores-Garcia, W., 2015. Mass Movement Processes triggered by Land Subsidence in Iztapalapa, the eastern part of Mexico City. Special Issue: Prevention and mitigation of natural and anthropogenic hazards due to land subsidence. Ninth International Symposium on Land Subsidence (NISOLS). Proc. IAHS, 372, 261–265, proc-iahs.net/372/261/2015/ doi:10.5194/piahs-372-261-2015.
8. Wang, Z., Zhang, Y., Wu, J., Yu, J., and Gong, X., 2015. Numerical simulation of earth fissures due to groundwater withdrawal. Special Issue: Prevention and mitigation of natural and anthropogenic hazards due to land subsidence. Ninth International Symposium on Land Subsidence (NISOLS). Proc. IAHS, 372, 395–398, proc-iahs.net/372/395/2015/ doi:10.5194/piahs-372-395-2015.

3.7. Activities involving other IGCP projects, UNESCO, IUGS or others

UNESCO IHP Working Group on Land Subsidence. Ninth International Symposium on Land Subsidence, November 2015, Proc. IAHS, 372, Daito, K. and **Galloway, D.** eds., 2015, http://proc-iahs.net/372/.

UNESCO IHP Working Group on Land Subsidence. Presentation at the American Geophysical Union Fall meeting. December 2015. H51A-1344: The UNESCO-IHP Working Group on Land Subsidence: Four Decades of International Contributions to Hydrogeological Related Subsidence Research and Knowledge Exchange, by ***Devin L. Galloway****,* ***Dora Carreón-Freyr****e,* ***Pietro Teatini*** *and* ***Shujun Ye****,* *https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/67403.*

UNESCO IHP U.S. National Committee Meetings. Participated in semi-annual meetings: ***Devin Galloway*** *presented progress and updates of IGCP-641 project.*

3.8. Scientific Legacy: Is there a need for storage of publications, field data, and other results of the project? Do you have a clear vision concerning where the data would be stored and who will be the custodian?

Yes, we have the need to store the input and output database of the project, a server can be acquired and managed by the Universidad Nacional Autónoma de México (UNAM) or by the University of Padua and/or a space in the cloud can be rented.

3.9. What tangible improvements has your project obtained? (Besides publications, we are interested to hear about improvements to research, scientific contacts, policy implications, etc)

We are working on knowledge exchange regarding the implementation of public policies in developing countries such as Mexico and Indonesia, taking successful examples from Japan, the Netherlands and USA, and also taking lessons and successful experience from the developing country of China.

3.10. What kinds of activities in respect to the benefit of society and science outreach has your project undertaken?

We are emphasizing the dissemination of the project results and focusing on engaging students and young researchers to actively participate in the project. We are including government officials in the project as well.

3.11. What kind of public information (media reports, etc) has your project generated? And how do you evaluate their impact?

The proceedings of the NISOLS were published by the International Association of Hydrological Sciences (IASH) that have a worldwide distribution.

We are working on having a link to our IGCP-641 project in the websites involved with groundwater, natural resources and risk management in different countries.

4. Activities planned

4.1. General goals

Enlarge the M3EF3 participant network of researchers;
Continue the integration of a map of worldwide occurrence of ground failure with related metadata (related papers, fissure geometry, causes, etc.);
Model 3D land subsidence and Earth fissuring at the selected study sites.

4.2. Tentative list of specific meetings and field trips (please list the participating countries)

Organization of the Second IGCP-641 Workshop, that will take place in November 2016 in Puerto Vallarta, Mexico. In association with the Mexican Geophysical Union (UGM, Union Geofisica Mexicana) and the Universidad Nacional Autónoma de México (UNAM).

Organize a field trip in Mexico and/or in other countries, like Indonesia.

5. Project funding requested

$ 5000 USD

Mainly for supporting students and/or researchers from developing countries (particularly from Africa) to attend the next meeting in Mexico.

6. Request for extension, on-extended-term-status, or intention to propose successor project

N/A

7. Financial statement ($ USD only)
The IGCP Scientific Board would like to be informed how the IGCP funds were used.

- 3000 USD were used for the organization of the 1st IGCP-641 workshop at Nanjing University (material, usb, transportation, etc.);
- 1000 USD support for two researchers to give an invited talk in the workshop (Italy) and to give a talk in the NISOLS (China);
- 1300 USD grants for students for attending the workshop and/or the NISOLS
- 100 USD for the rent of the domain for the website and to register an abstract in the American Geophysical Union Fall Meeting.
- 100 USD material expenses

8. What additional funding besides the IGCP seed funding has your project obtained thanks to the IGCP label? Please estimate the budget received for meetings, research or other and identify the source.

N/A, we have not yet sought other funding besides IGCP;

The workshop was also sponsored about 2000 USD by:
- The School of Earth Sciences and Engineering of the Nanjing University,
- The Key Laboratory of Earth Fissures Geological Disaster of the Ministry of Land Resources, China, and
- The Geological Survey of Jiangsu Province

9. Attach any information you may consider relevant

An Annex I with information about the 1st IGCP-641 workshop held at Nanjing University is attached to this report. This includes grant receipts of professors and students and the workshop program document.

The three main NISOLS publications and the AGU abstract and poster are also attached to this report.