Mid-term Assessment 11 March 2016

Wuhan University – Delft University of Technology
Joint Research Centre on Spatial Information

Peter van Oosterom and Jianya Gong (Scientific directors of the JRC)
Summary

This report contains both the result of the mid-term assessment of the Wuhan University – Delft University of Technology, Joint Research Centre (JRC) on Spatial Information and the self-assessment preparation materials. The assessment of the JRC was conducted on 11 March 2016 by the assessment committee on behalf of the TUD board (vice rector Peter Wieringa) and the JRC Advisory Board (AB chair Deren Li). The self-assessment input materials illustrate the obtained results during the past first three JRC years: increased staff/PhD/MSc student exchanges, variety of research proposals created, submitted and some awarded, jointly developed open source software: a.o. for vario-scale maps, indoor navigation, and satellite data processing software, first double degree PhD students started, and a large number of jointly authored scientific publications. The self-assessment materials further describe the JRC plans for the near future: higher numbers of jointly supervised PhD students, attract more research funding on both sided using JRC strengths, conduct even more joint research and possible education/training, organize next AB-meetings. In addition some very important opportunities of the JRC are that the National Chinese Ministry of Education recognized the JRC status of Wuhan-Delft for the next three years (2016-2018) and the anticipated changes in the Dutch educational law (WHW) enhancing international collaborations, and creating better possibilities for double degree MSc programmes, also with non-EU partners.

The assessment committee recognized the achievements and appreciated the ambitious future plans of the JRC and stated “We are both satisfied with the work and achievements in the past three years. We are also very optimistic and positive for the future development of JRC.” In addition several suggestions for the future strategy were made: try to benefit from the new scholarship policy of Chinese government that can attract more young students and researchers from TUD to come to Wuhan University, further reinforce the interaction with the members of the JRC Advisory Board, seriously investigate and consider double degree education on master level, have more professors / researchers from TU Delft visiting Wuhan University, suggest TU Delft to join Wuhan University to build a worldwide training network of UN-GGIM (United Nations - Global Geospatial Information Management). During the mid-term assessment meeting it was also agreed to make public the self assessment materials and the actual assessment (this document).
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1. Mid-term Assessment

The assessment of the Wuhan University (WHU) – Delft University of Technology (TUD) Joint Research Centre (JRC) on Spatial Information by the TUD board (vice rector Peter Wieringa) and the JRC Advisory Board (chair Deren Li) was based on the input of the JRC self-assessment report (part A and B and appendices 1-4) and the presentations at Wuhan University on 11 March 2016 in the morning (appendix 5).

The actual mid-term assessment did take place in a closed session, during the afternoon of 11 March 2016, with the following independent assessors present: Peter Wieringa, Deren Li, Krista Knopper (TUD International Strategic Partnerships), Anna Luo (WHU International Office), and Li Zhang (WHU Graduate School). The result of the assessment was presented in the public plenary session on 11 March 2016 as delivered by Deren Li, President of the WHU Academic Committee:

“We are very glad to tell you that today we had a very nice talk with Prof. Peter Wieringa and his staff. We are both satisfied with the work and achievements in the past three years. We are also very optimistic and positive for the future development of JRC.

Based on JRC, many young students are trained well to PhD and master degree. There are also a lot of cooperative research projects with good results. In the future, we hope that the new scholarship policy of Chinese government can attract more young students and researchers from TUD to come to Wuhan University. We also hope that the double degree education on master degree between the two universities can be carried out soon.

We exchanged comments from advisory board members of both sides. The development of JRC counts a lot for both, and they keep very close contacts with the administration team of JRC. We hope we can get more support from these members for our further cooperation.

We also welcome professors and teachers from TUD to come Wuhan University to give regular lectures, as well as join our international school education, to promote exchanges and communication between scholars and students.

More importantly, we cordially invite TUD with us to build a worldwide training network named UN-GGIM for young generation in the area of Geospatial Information.

Thank you.”
2. Background

The planned TU Delft JRC evaluations are intended to reflect on the start-up period of the TU Delft JRC initiatives and to focus on ‘what worked well in specific overseas settings, where do the challenges lie and/or opportunities for the future, how can the TU Delft support the specific initiatives to be more successful’, etc. For the evaluations the (representative of the) TU Delft Board will visit the JRC locations in the involved countries during the year 2015-2016. The evaluation of the WHU-TUD JRC on Spatial Information (the JRC) will take place in Wuhan on 11 March 2016.

The self-assessment report consists of two parts: A and B. The structure is the same for all self-assessment reports by the various JRCs. Part A includes the reflections on the past, the current and the expected future situation related to the original five objectives of starting TU Delft JRCs:

1. Expand and develop academic relations in emerging knowledge economies
2. Attract talent from abroad
3. Submit proposals to or enter into alliances with funds abroad
4. Gain access to state-of-the-art laboratories and new research environments
5. Serve as a trailblazer for Dutch business and industry

Information provided for the questions in part A primarily serve as input for the evaluation interview of the JRC. This is complemented by an up-to-date overview of the JRC fact & figures (Part B).
3. Part A – The Five Objectives

This part of the self-assessment reflects on the past, the current, and expected future situation related to each of the five original objectives of the TU Delft JRC initiatives.

1. Expand and develop academic relations in emerging knowledge economies

PAST: the relationship between TU Delft (TUD) and Wuhan University (WHU) has a quite long history on spatial information; however the relationship is kept by academic visiting, meetings, student exchanges, case by case.

This is explained by the fact that WHU, China is the world largest university in spatial information (geodesy, geomatics, remote sensing, geo-informatics) with an academic staff of more than 350 and very big student numbers: BSc 3000, MSc 1000, and PhD 500. Also, the quality is world leading and reflected in scientific journal publications and key positions of their staffs in international organizations. Further, Wuhan University is also the home of the State Key Laboratory of Information Engineering in Surveying Mapping and Remote Sensing (LIESMARS), the first one and the best one in China in this field.

PRESENT: the formal status, the efforts, and the additional seed funding, did cause a more intense relationship with Wuhan University. Very important in the organization of the JRC, is the establishment of an independent Advisory Board (AB); see Appendix 3. The AB is chaired by prof. Deren Li (Chairman of WHU Academic Committee, member of both the Chinese Academy of Sciences and the Chinese Academy of Engineering) and has representatives from the following organizations (3 from both the Chinese and the Dutch side):

1) Xiaohan Liao, Director General, National Remote Sensing Centre of China (NRCC);
2) Pengde Li, Deputy Administrator, National Administration of Surveying, Mapping and Geoinformation of China (NASG);
3) Renzhong Guo, Deputy Director General, Urban Planning and Land Resource Commission of Shenzhen Municipality;
4) Gert Dral, Board of Directors, Grontmij;
5) Kees de Zeeuw, Director, Kadaster International;
6) Mart van Bracht, Director, Netherlands Organisation for Applied Scientific Research TNO.

The support of TU Delft, Valorization Centre in the person of Cees Timmers was very important. In the past Cees was already the link to the CSC PhD students, but in the JRC he became the operational coordinator. He acted more as a strategic advisor, rather than a coordinator (and with his retirement approaching this is a point of attention). The top-level support of the JRC by the University Boards is another element of the success of the JRC. A rough estimation is that during the run of the JRC, the collaborative activities were more or less doubled, compared to the period of collaboration before the JRC.

FUTURE: the JRC should consolidate to a mature and stable organization. Important is to find/attract a successor of Cees Timmers, as TU Delft operational coordinator. One of the main goals for the near future is to increase the number of projects in which there is true cooperation, that is, staff members of both organizations involved. This will further deepen the academic relations between TU Delft and WHU. Of course, first of all joint projects with the existing, active JRC partners, but also the start of joint research with new partners (from within WHU or from a wider
circle; e.g. in collaboration with researchers from AB-member organizations) should be explored. The JRC did get national Chinese recognition by the Ministry of Education (MOE) on 16 October 2015. This has big implications for the JRC, as the academic ambition level is further raised. The new national status of the JRC is for three years (1 Jan. 2016-31 Dec. 2018) and on the axis Wuhan – Delft, both sides are expected to fulfill the role of international hub’s. For Wuhan this implies attracting talents from China and South-East Asia (Thailand, Malaysia, India, Singapore, Korea and Japan), and for Delft this area is the whole EU (and beyond). An important goal is that talented scholars will spend longer periods (2-3 months or longer) in Wuhan. Further, international student exchange gets a high(er) priority, both at the MSc and the PhD level. Activities related to the future UN-GGIM (United Nations Committee of Experts on Global Geospatial Information Management) Academic Network fits within the raised ambition level.

*The JRC WHU-TUD Advisory Board (and friends), after their first meeting on 21 January 2013 (Wuhan, China)*
2. Attract talent from abroad

PAST: via ‘ad hoc contacts’, the decade before the formal start of the JRC, there was a semi-regular flow of CSC PhD students, visiting postdoc and professors. From TU Delft, prof. Teunissen has been teaching in Wuhan University since the late 1990's, and prof. Hanssen is teaching in Wuhan since 2010. Teunissen is honorary professor at Wuhan, and Hanssen is guest professor since 2011. Prof. Liao Mingsheng visited Delft in 2014 and expects to return in 2016 for a sabbatical. The nature of the visits was for a limited time ranging from a couple of months for visiting scholars and up to 4 years in case of a PhD. Some PhD candidates from Wuhan returned to China after their graduation in Delft, while others stayed in the Netherlands and found high ranking positions, e.g. in Fugro (Xianglin Liu) and Shell (Shizhuo Liu).

PRESENT: the JRC has caused increased visibility (thanks to the JRC marketing). At the TU Delft side, the JRC is in close collaboration with the University Corporate Office (UD, Universiteitsdiensten) and also the TU Delft Valorisation Centre (Cees Timmers as operational coordinator) is heavily involved. Another example is the efforts to enable the dual degree PhD agreement (GS, Legal Services). This makes the JRC and the double degree PhD, a very attractive option for PhD candidates. It is expected that in the near future – when the double degree PhD registration/agreement has been signed – this will further attract young talent. Positive experience was also obtained with various MSc student activities: the TU Delft MSc Geomatics Synthesis Project conducted in Wuhan in 2013, but also some individual student exchange arrangements (as part of their regular course work or their MSc thesis research). In addition to the PhD double programme, also a double degree MSc programme (Geomatics) has been considered. However, given the high fees for Chinese students to study in Delft (and the low/no fees for Dutch students in Wuhan) this was considered not feasible and/or fair. Together with Delft collaborators, Wu Wenhao is working on software development for satellite data processing. He visited TU Delft for 4 months in 2015 to collaborate and exchange ideas.

FUTURE: given the fact that the Dutch educational law (WHW) is expected to change in the near future with the goal to further enhance international collaborations, this makes the double degree MSc programme a more feasible option to be explore further. As there are very tight relations between research and education, both activities will benefit. This will enable spotting and attracting talent even earlier (and let them participate in research via MSc thesis topics or other research education projects). For this an agreement at university level should be made, which should now be possible within the near future in Dutch educational law (WHW); e.g. students only pay fees in their own country. In addition, the new National Chinese MOE status of the JRC is also expected to attract more talents from China, South-East Asia, and Europe based on the hub-function of the Wuhan-Delft axis.
3. Submit proposals to or enter into alliances with funds abroad

PAST: a limited of joint proposals have been submitted in the past. Despite this fact, there has been quite a bit of research collaboration and visits, due to the fact that both WHU and TU Delft did have their own relevant project proposals funded and on-going.

PRESENT: a large number of joint research proposals have now been described (up to a certain level of detail); see facts & figures question 16. Out of these 11 topics, 4 proposals have been completed and submitted: ‘Integrated Urban Intelligent Management Technology and its Applications based on 3D GeoInformatics’, ‘Unification of World Height Datum’, ‘Geo Big Data Generalization and Visualization’, and 'High-precision positioning for SAR interferometry'. The last project was funded for a 4 year PhD program (Mengshi Yang). The other proposals were not yet funded, but hopefully revised versions of these proposals will receive funding in 2016. Though not truly a joint WHU-TUD project, the recently approved proposal ‘Vario-scale representation of Shenzhen maps’ by Martijn Meijers gets quite close to it. It was submitted early 2015 to the open project call of the Key Laboratory of Urban Land and Resources Monitoring and Simulation, Ministry of Land and Resources (located in Shenzhen, by Renzhong Guo, JRC AB-member). The vario-scale proposal (based on knowledge patented by TU Delft) was approved and funded with 180,000 RMB. The contracting is still on-going and this is an interesting case, because money should be transferred from China to TU Delft (as work will be conducted mainly in Delft). The support of the University Corporate Office (UD, Universiteitsdiensten) is very important here, again via the efforts of the Valorization Centre (Cees Timmers).

FUTURE: the first joint project is now awarded. Some of the other (new and revised) proposals should be developed to mature level to be submitted to funding organizations. Continuous maintenance of a joint research agenda is needed for this purpose. In addition to jointly submitted proposals, also proposal submitted by one partner, but involving the other partner (via visits, double degree PhD, etc.) is an effective collaboration model as both partners have a good track record in the area of writing research proposal that are funded and with the additional asset of the JRC (a world class partner), the future research proposals should become even stronger. Besides WHU and TU Delft, also the Advisory Board may provide input here. A more tight collaboration with some (Dutch) Advisory Board members (Kadaster, Grontmij, TNO) is targeted. Also non-AB, but Dutch, organizations could be involved in future JRC research; e.g. Fugro (http://www.fugro.com/) or CycloMedia (http://www.cyclomedia.com/en/). The collaboration with the other Chinese AB-members could develop further; e.g. with the National Remote Sensing Centre of China (NRCC) and with the National Administration of Surveying, Mapping and Geoinformation of China (NASG). And in a similar manner, this could also be extended beyond current Chinese AB members. Finally, the new National Chinese MOE status of the JRC also brings additional funding for research on the Wuhan-Delft axis.
4. Gain access to state-of-the-art laboratories and new research environments

PAST: via more ad hoc contacts in the times before the JRC, we were aware of the various facilities and data sets in China (Wuhan). However, the use of these facilities was very limited (and often indirect, i.e. via Wuhan University staff).

PRESENT: due to the JRC collaboration we now have more direct access to facilities and data, which is very helpful in our TU Delft research. A few examples will now be mentioned. 3D Cadastre has been a research topic at TU Delft for a long time. However, in the Netherlands (and many other European countries) it remains in the research phase. In China various cities, supported by Wuhan University, have taken steps towards actual implementation in practice. This gives new insights, but also new research challenges; e.g. usability of 3D cadastre. China has been, still is, and plans to launch a large number of satellites for various purposes: positioning, earth observation, communication, etc. Partnering with WHU, gives TU Delft excellent access to these rapidly developing resources.

The indoor localization and navigation solutions developed by WHU could be used by our TU Delft students for their MSc Geomatics Synthesis Project. TU Delft MSc thesis student Kaixuan Zhou visited Wuhan for his MSc research and used the Wuhan point cloud data processing facilities and expertise. Through prof. Hanssen's guest professorship, there is a close connection to the facilities of Wuhan's GNSS data center, leading to the development of joint software tools for satellite data processing.

FUTURE: WHU and TU Delft will collaborate in a joint ESA-MOST funded project on high-performance computing in satellite data processing, leading to the use of each others high-performance computing facilities. The reuse of each other facilities will grow further (among others by double degree PhD students). We should realize that it should work in both directions. So, also Wuhan staffs and students should be able to benefit from facilities in Delft and vice versa. In the far future, and depending on the size of funded (joint) projects, Wuhan and Delft should decide on, and design together research facilities.

5. Serve as a trailblazer for Dutch business and industry

PAST: not really applicable in the past.

PRESENT: the relationship with Dutch business and industry has been reinforced due to the JRC (and the related Advisory Board activities). These activities are not per se always focused on Wuhan, China, but sometimes also broader; e.g. collaboration with Kadaster International in various activities (3D Cadastre Pilot in the Russian Federation, development of the Land Administration prototype based on ISO 19152 in Colombia) or participating in the ‘Kennis Positie Audit’ of TNO’s Earth Cluster. Fugro is benefitting from the close collaboration with Wuhan, and Dutch SMEs (such as SkyGeo) recruit staff from Wuhan alumni.

FUTURE: it is very likely that our current (and future) partners will also experience the positive effects of the JRC. Of course, this applies to the AB-member organizations, but quite likely also to our other partners; Fugro (this is already the case), CycloMedia, etc.
4. Part B – Facts & Figures

1. Name and physical location Wuhan University-TU Delft JRC (contact details)
State Key Laboratory of Information Engineering in Surveying Mapping and Remote Sensing (LIESMARS), Information Science Campus, Wuhan University, 129 Luoyu Road, Wuhan, China.

![Birds eye view of a part of the Wuhan University campus](image)

2. Principle academic partner and/or organization overseas
Wuhan University, with the following schools, institutes:
   1) State Key Laboratory of Information Engineering in Surveying Mapping and Remote Sensing (LIESMARS);
   2) School of Resource and Environmental Science;
   3) School of Remote Sensing and Information Engineering;
   4) School of Geodesy and Geomatics;
   5) GNSS Research Centre;
   6) School of Urban Design.

3. Length of existing relationships with above mentioned partner
For a period of more than 15 years the various geo-groups have been collaborating. Before the official formation of the JRC November 2012, this was more or less at ‘ad hoc’ level (e.g. CSC PhD’s, postdocs, 2000 honorary prof. Peter Teunissen, Tinghua Ai first Wuhan visiting professor at TUD, GIS technology, MoU 2006 Physical Geodesy, 2012 guest prof. Ramon Hanssen, …).
4. Additional academic partners and/or organizations in the Netherlands or overseas, if any

The JRC has an advisory board, consisting of a mix of industry, government and research organizations (See Appendix 3). The members are:

1) Xiaohan Liao, Director General, National Remote Sensing Centre of China (NRCC);
2) Pengde Li, Deputy Administrator, National Administration of Surveying, Mapping and Geoinformation of China (NASG);
3) Renzhong Guo, Deputy Director General, Urban Planning and Land Resource Commission of Shenzhen Municipality;
4) Gert Dral, Board of Directors, Grontmij;
5) Kees de Zeeuw, Director, Kadaster International;
6) Mart van Bracht, Director, Netherlands Organisation for Applied Scientific Research TNO.

5. Are there any legal and/or governance aspects, see points below, that play a crucial role or need to be thought of or resolved

(Compliance with Dutch Law (WHW, including financial regulations, etc.), Compliance with foreign law, Legal form of cooperation (contract, legal entity, joint venture, etc.), Liability/risks/insurance, Fiscal aspects/requirements, Profile/reputation, Governance structure, Appointment scientific and operational coordinator on both sides)

Projects (and involved staffs, postdocs, PhDs) are funded at own side, so there exists no flow of money from China to the Netherlands and v.v.. In (near) future this might change, and this issue needs to be resolved.

The double degree PhD regulations have been agreed upon by Wuhan University (Jianya Gong) and TU Delft (Karel Luyben) during the August 2014 workshop in Delft. First double degree PhD students have started (see question 24 below).

Discussing future plans during the 2014 JRC Workshop in Delft.
The double degree MSc programme has not started, because it is not realistic for most Chinese students to pay the fees at TU Delft (and Wuhan is asking no fees from their side). As suggested by the initiator of the JRCs and former TU Delft President Dirk Jan van den Berg an option could be to make an agreement between both universities not asking fees from students from the counterpart university. As indicated in Part A of this document, the Dutch educational law (WHW) is expected to change in the near future and allowing the university boards to decide on their fees. This might also make the double degree MSc programme a more feasible option. Normally a MSc programme takes 2 years to complete at a single location. A double degree MSc programme would take 3 years (of which 1 year will be spent at the other location). Wuhan University has experience with a double degree MSc programme with TU Munich (no fees involved).

6. Details of JRC Academic Directors at TU Delft

Prof. Peter van Oosterom
TU Delft, Faculty of Architecture and the Built Environment
P.J.M.vanOosterom@tudelft.nl

7. Details of JRC Academic Directors overseas

Prof. Jianya Gong
Director LIESMARS
gongjy@whu.edu.cn

8. Details of JRC Operational Coordinator at TU Delft

Cees Timmers
TU Delft, Valorization Centre
C.Timmers@tudelft.nl

Elfriede M. Fendel
TU Delft, Faculty of Architecture and the Built Environment
E.M.Fendel@tudelft.nl

9. Details of JRC Operational Coordinator/Director overseas

Prof, Huayi Wu
LIESMARS
wuhuayi@whu.edu.cn

10. Details JRC Overseas office/support staff (name & position) if relevant

Ms. Lite Shi
LIESMARS, international affairs
lilyshi@whu.edu.cn
11. Funding of the TU Delft Executive Board received
Period of funding: 3-year seed funding (2012-2015): total € 252,000

12. Funding matched by the foreign partner
Yes, WHU provides the same amount in the same period of funding: 3-year seed funding (2012-2015): total 1,800,000 RMB.

13. Budget holder(s); who is responsible for the Budget and/or has a mandate to spend; up to what maximum amounts (signatures)
Prof. Peter van Oosterom

14. List targeted research funds and/or government funding agencies in the Netherlands, Europe and overseas
More details in Appendix 2, a short extract here:

**Netherlands/Europe**
1) Vidi NWO STW
2) OTP (Open Technology Programme) STW
3) Collaboration with Dutch Kadaster
4) Bsik NGInfra
5) Data policy for the Dutch Ministry of Infrastructure and Environment (Rijkswaterstaat)
6) Data policy for Dutch Utilities, Alliander
7) Open Program of NWO
8) China/NL Joint Scientific Thematic Research Programme (NWO)
9) Shell, PhD funding
10) CATO-2, PhD funding
11) FP7 project ELF (European Location Framework)
12) European Space Agency, Dragon program

**China**
1) National Natural Science Foundation of China
2) Fundamental Research Funds for the Central Universities of China
3) National Special Fund for Land Resource Scientific Research in the Public Interest
4) Shenzhen Municipal Project
5) CSC funding
6) Key 863 project
7) 973 project
8) Technology Support Program
9) Dragon-3 project
10) 111 project

15. Which additional local and global research funds/organizations could/will be investigated and approached
More emphasis could be put on European calls (in the H2020 context).
Also the Royal Netherlands Academy of Arts and Sciences (KNAW) call offers opportunities:
China Exchange Programme (CEP).

In China new opportunities are the open project calls of the Key Laboratory of Urban Land and Resources Monitoring and Simulation, Ministry of Land and Resources (located in Shenzhen, by Renzhong Guo, JRC AB-member). The national status awarded for three years (2016-2018) by the Chinese MOE of the JRC should further increase the research funding opportunities.

Special Note: the research funding system is restructured in China from 2016, and will have a leap on funding international collaborative activities.

16. List number of submitted or to be submitted research proposals

Include partners and organizations/funds involved in the Netherlands and/or abroad

- Various joint research proposals prepared, one of which was submitted in 2013 to MoST: Integrated Urban Intelligent Management Technology and its Applications based on 3D GeoInformatics (after positive evaluation in 2014, now on MoST waiting list).
- Research proposal 'Unification of World Height Datum' to the National Science Foundation of China (NSFC) by Prof. Dr. WenBin Shen (School of Geodesy and Geomatics, WHU) and Prof. Dr.-Ing. habil. Roland Klees (GRS, TUD): China, 3.6 million yuan RMB from NSFC.
- Research proposal 'Geo Big Data Generalization and Visualization' to the National Science Foundation of China (NSFC) by Dr. Jingzhong Li/ Prof. Dr. Tinghua Ai/ Dr. Xiang Zhang (School of Resource and Environmental Sciences, WHU) and Prof. dr.ir. Peter van Oosterom (GISr, TUD): China, 3 million yuan RMB from NSFC.
- Research proposal: 'Near-Real-Time InSAR data processing' to the Ministry of Science and Technology (MOST) and the European Space Agency (ESA), by Profs. Deren Li, Liao Mingsheng, (WHU) and prof. Ramon Hanssen (TUD).

In total 11 research topics/draft proposals were prepared and presented during the August 2014 workshop (topics 3 and 10 have been submitted):

GRS-Physical and Space Geodesy presented by Qile Zhao.

1. Direct use of GNSS phase and code measurements of LEOs to estimate the Earth’s gravity
   Individual research project 1 (TU Delft – GNSS research centre)
   - Keywords: kinematic accelerations from line-of-sight velocities; stochastic modelling; acceleration approach; kinematic satellite orbits; added value of high-precision inter-satellite ranging.
   - Visiting PhD student (1 year); starting late 2014!!
   - Funding: JRC.
   - PIs: Qile Zhao, Roland Klees.

2. Improved methodology for monitoring the time-varying gravity field using data of GRACE/GRACE-FO & SWARM satellites
   Individual research project 2 (TU Delft – GNSS research centre + SGG)
   - Keywords: refined data processing methodology (LOS velocities and accelerations, a priori along-track filtering; space-localizing parameterization); combination of GRACE and SWARM baseline data; application to ice mass balance and river-basin scale hydrology
   - PhD double degree student (candidate selected).
   - Funding: CSC, JRC (CICG 2011).
   - PIs: Qile Zhao, Roland Klees.
3. Height system unification and connection
   Individual research project 3 (TU Delft – SGG).
   - Keywords: geoid modelling, ocean model, dynamic sea surface topography, radar altimetry, sea level, GNSS, tide gauges.
   - Double degree PhD student.
   - Funding: NSFC.
   - PIs: Qile Zhao, Roland Klees.

GRS-Optical and Laser Remote Sensing presented by Ben Gorte
   High-resolution optical satellites:
   - Ziguan-3, three line scanner 2.8 m resolution → stereo;
   - GF-2, launched August 19th, 2014, 0.8 m resolution.
   - Together resulting in a very high resolution Ortho.
   Wuhan responsible for calibration and validation in 2015.
   The idea is to work together on this on the basis of AHN-2.
   PIs: Deren Li, Ben Gorte.

5. Fully automatic 3D city modelling from AHN-2: exchange of experiences
   Wanted:
   - Fully automatic models, however simple these may be.
   - Improvement of automatically reconstructed roof models: make edges horizontal, parallel, perpendicular, etc.
   The idea is to work together on the basis of automatically formulated and tested hypotheses.
   PIs: ?, Ben Gorte.

6. Real-time indoor registration and modelling using range cameras (e.g. Kinect)
   - Wuhan has much experience with indoor 3D data acquisition using many different devices (3D laser scanners, Creaform Handyscan, 2- and 4-camera rigs, etc.
   The idea is to add range cameras to the above, including plane segmentation and plane-based co-registration according to Gorte-Sithole [2012] (which needs to be further developed).
   PIs: Zhichao Zhang, Ben Gorte.

GRS-Radar Remote Sensing and Positioning (not presented during AB)
7. High-precision positioning for SAR scatterers: applications for railway monitoring
   TU Delft and Wuhan University propose to further collaborate on this topic, in a team of (to start) 1 PhD student (Gert Mulder) and 1 PostDoc (Ling Chang) in Delft, and 1 PhD student (Mengshi Yang) in Wuhan.
   The goal is to
   - improve the geo-localization precision to the sub-decimetre level (for medium resolution sensors);
   - map the corrected position of the scatterers to a 3D model of the environment. (This could be an additional (PhD) project, to be decided);
   - improve the stochastic description of the estimated locations.
   Both students: Gert Mulder (TUD) and Mengshi Yang (WHU) will have complementary research goals, with frequent (half-yearly) meetings in Wuhan or Delft, and monthly Skype
meetings.
PIs: Liao Mingsheng and Ramon Hanssen: status ongoing.

**OTB – GIS technology & Geo-information and Land Development by Huayi Wu (8 & 9) and Peter van Oosterom (10 & 11)**

8. Seamless integration of outdoor & indoor 3D modelling and navigation for critical infrastructure protection
   - Keywords: BIM, 3D modelling, indoor navigation, context-awareness, semantic, spatial-temporal optimization.
   - PhD Student: 1 from CSC type I support (Xinyan Zhu), young visiting scholar from MOE.
   - PIs: Xinyan Zhu and Sisi Zlatanova.

9. Large-scale spatiotemporal geographic process simulation for time-critical applications – Key technologies and demonstrations
   - (Due final CFP from NSF).
   - Keywords: HPC, Cloud, Sensor-web, time-critical, disaster-alerting, urban heat island
   - Funding source: NFS Key Program, NWO?
   - PhD student: 1 from CSC type I or II support (Huayi Wu).
   - PIs: Huayi Wu and Jantien Stoter.

10. Geo big data generalization and visualization
    - Scientific topics:
      - big geo-data
      - geo-web services
      - scaleless representation
      - inclusion of VGI?
      - quality evaluation of generalized result (formal specs),
      - convert generalization processes into a data structure (vario-scale),
      - continuous generalization (smooth-zoom).
    - Double degree PhD student, supervisors.
    - Natural Science Foundation (NSF), fundamental research
    - PIs: Tinghua Ai, Peter van Oosterom.
    - English draft first.

11. 3D Registration/Administration
    - Topics:
      - New legal reality, REURS (Real Estate Unified Registration System).
      - Scope: land, infrastructure, buildings, architecture
      - Relation: real world object – legal spaces (RRRs).
      - Legal and institutional aspects.
      - Representation of the 3D objects (may be open, non-manifold).
      - Topology and solid construction (validation and check).
17. Which viability aspects play a role or need to be thought of or resolved

Can the JRC be self-supportive?, When will the JRC be self-supportive?, How will the JRC be self-supportive?, Funding, Financial and administrative reporting (i.e. consolidation)

In some form the JRC will continue to exist. The formalization of the JRC in November 2012 and the additional funding by the two boards has resulted in a significant impulse: roughly estimated the amount of collaborations/visits has doubled. Very important is the double degree PhD programme, which still has to be formalized (this will attract more PhD talent in the future). It is the intention to sign the agreement during the March 2016 meeting in Wuhan. What remains to be achieved: double degree MSc programme and the further increase of true collaborative and joint projects (financed by third parties). More patience was needed than what was initially expected. However, within the original time-frame of the MoU 5 years, it is realistic that also this can be realized. The National Chinese MOE status for the next three years (2016-2018) of the JRC even further raises the academic ambitions. This will require further investments at both sides: attracting scholars from whole Asia and Europe, maturing the double degree PhD programme, investigating and possible setting-up also double degree MSc programme, etc. Two to three more years with financial support (at the same level as first 3 years) by the boards should be allocated as investment. The final goal remains unchanged: being self-supportive JRC.

18. List future NEW possible or targeted academic relations

The Key Laboratory of Urban Land and Resources Monitoring and Simulation, Ministry of Land and Resources (located in Shenzhen, by Renzhong Guo, JRC AB-member). Further, the School of Urban Design is part of the JRC, but until today not involved in any of the activities.

19. List existing business/industry relations

As indicated in response to question 14, organizations such as Shell, Rijkswaterstaat, Alliander, Kadaster are important business relations and (partly) funding research. Also, a similar situation does exist at Chinese side (often with government partners). With Shenzhen municipality, also hosting the Key Laboratory of Urban Land and Resources Monitoring and Simulation, Ministry of Land and Resources, a first project was last year awarded to TU Delft: 'Vario-scale representation of Shenzhen maps'. Vario-scale maps are based on a patent by TU Delft (Van Oosterom and Meijers).

20. List future possible or targeted business/industry relations

Collaboration with some (Dutch) Advisory Board members (Kadaster, Grontmij, TNO) could be made stronger. Also non-AB, but Dutch, organizations could be involved; e.g. Fugro or CycloMedia. In the future also the collaboration with the other Chinese AB-members could develop further; e.g. with the National Remote Sensing Centre of China (NRCC) and with the National Administration of Surveying, Mapping and Geoinformation of China (NASG). Targeted business/industry relations with local companies such as GeoStar, Leador are desirable and possible. GeoStar has already started its European office in Sweden, this can of course expand to the Netherlands, if there is marketing opportunities.
21. Role as trailblazer for Dutch business and industry – yes/no

Supporting ministry and business delegations, Involving business in advisory councils, Supporting companies in acquiring projects, Joint projects with business, industry and government

Yes, the relationship with Dutch business and industry has been reinforced due to the JRC (and the related Advisory Board activities). These activities are not per se focused on Wuhan, China, but some times also broader; e.g. collaboration with Kadaster Internationaal in various activities (3D Cadastre Pilot in Russian Federation, Development of Land Administration Prototype based on ISO 19152 in Colombia) or participating in the ‘Kennis Positie Audit’ of TNO’s Earth Cluster.

22. List research or experiments to be conducted in overseas labs and or research environments

Due to the JRC collaboration we have access to facilities and data that is very suitable for our TU Delft research. 3D Cadastre has been a research topic at TU Delft for a long time. However, in the Netherlands (and many other European countries) it remains in the research phase. In China various cities, supported by Wuhan University, have taken steps towards actual implementation in practice (given new insights, but also new research challenges); e.g. usability of 3D cadastre.

China has been, still is, and plans to launch a large number of satellites for various purposes: positioning, earth observation, communication, etc. Partnering with Wuhan, gives TU Delft excellent access to these rapidly developing resources.

The indoor localization and navigation solutions developed by Wuhan University could be used by our TU Delft students for their MSc Geomatics Synthesis Project '3D indoor navigation system for the Hubei Provincial Museum (Daren)'.

TU Delft MSc thesis student Kaixuan Zhou visited Wuhan February-March 2015 for his research project 'Knowledge Based Regularization of Façade Reconstruction from Point Cloud' and used their point cloud data processing facilities and expertise. Supervision by Ben Gorte (GRS, TUD) and Zhichao Zhang (School of Remote Sensing and Information Engineering, WHU).

23. Number of joint research projects in progress

The first activities that fully deserve the name joint project are the two double degree candidates who have recently started (see question 24 below). With the drafted and some submitted proposals (see question 16) this should soon increase further. As stated, many visits and joint activities were conducted. These forms of collaboration have resulted in a substantial number of tangible research results; e.g. scientific papers and presentations (see question 27 below).

24. Number of TU Delft registered PhDs involved

Names and details of joint projects including PhD students and TU Delft and /or overseas supervisors involved as well as joint publications (existing and or upcoming)

Registration at TU Delft Graduate School; yes/no

List additional attracted talent; PhD, Post Docs, BSc, MSc students

Dr. P. Ditmar (TUD copromotor), Prof. Dr.-Ing R. Tenzer (Wuhan University, China, copromotor).


In the second half of 2015 and currently finalizing her PhD research plan, the second double degree PhD student started: Mingxue Zheng. (supervisors: and prof. Huayi Wu of LIESMARS, WHU and GIS/TUD prof. Peter van Oosterom) on the topic 'Integrated multi-dimensional modelling for point cloud data applied to object detection' (provisional title and stay in Delft to be planned).

We are very proud of our TU Delft students for their MSc Geomatics Synthesis project '3D indoor navigation system for the Hubei Provincial Museum (Daren)', which was conducted in the fall 2013 during visit to Wuhan along with two teachers TUD (Sisi Zlatanova and Edward Verbree);

http://darenproject.weebly.com

The TU Delft MSc thesis student Kaixuan Zhou visited Wuhan February-March 2015 for his research project 'Knowledge Based Regularization of Façade Reconstruction from Point Cloud' (see Exchange_report_Kaixuan_Zhou.pdf). Supervision by Ben Gorte (GRS, TUD) and Zhichao Zhang (School of Remote Sensing and Information Engineering, WHU).

25. List past additional activities

Think of Visiting professorships, Seminars organized in the Netherlands and the partner country, Patents, Spin-offs, Involvement in advisory committees, Involvement in policy reports


- Organization of two two-day JRC Wuhan-Delft Workshops:
  - Formulation Workshop Wuhan University - TU Delft Joint Research Centre on Spatial Information, November 12-13, 2012 (Wuhan University, China)
  - Second Wuhan-Delft JRC Workshop, 19-20 August 2014 (TU Delft, the Netherlands)

- Organization of three advisory board meetings:
  - First Advisory Board, 21 January 2013 (Wuhan, China)
  - Second Advisory Board, 14 May 2013 (Delft, the Netherlands)
  - Third Advisory Board Meeting, 20 August 2014 (Delft, the Netherlands)

- Continuation visiting staff and PhDs (mainly from Wuhan to Delft, and often with CSC funding; among others students Yihao Wu and Xiang Guo, visiting professors Yeting Zhang and Lina Huang) and also for the next period more CSC funded staff and PhDs from China expected in Delft.

- Several joint publications after above mentioned research visits: some already completed, but another part still expected in 'aftermath' of these visits.

- Besides this internal Wiki for communication (see Appendix 1), also an external website has been developed: http://jrc.tudelft.nl/spatial-information

- Various joint research proposals prepared, and three submitted (and more pending to be completed and submitted). Among others, the preparation of research proposal 'Integrated indoor/outdoor navigation among moving obstacles' by Zhiyong Wang/Sisi Zlatanova (TUD) and Prof. Xinyan Zhu and Mr. Qing Xiong (WHU);
Visit of TU Delft conrector, prof. Wieringa, to Wuhan in the context of the 120-year anniversary of the University, but also the opportunity to discuss the possibilities double of dual degree PhD agreements between the Universities. The TU Delft conrector is in Delft also the chair of the ‘Doctorate board’.

Last week of 2014 WHU finished and submitted a proposal to the Chinese Ministry of Education about funding to support WHU-TUD joint centre. The proposal has passed the first round evaluation and will be further evaluated by the government (in the context of Chinese national policy to support international JRC’s).

Visit of Cees Timmers to Wuhan on 23 September 2015 to discuss the last details with respect to the agreement on the double degree PhD regulations (as discussed in the August 2014 workshop) and to prepare the

Meeting on 16 October 2015 with the Chinese Ministry of Education to assess the proposal to assign national status to the JRC for 3 years. Sisi Zlatanova from the TU Delft intended to participate in the meeting, but the actual date was known too late in order to obtain a travel visa. However, the meeting was successful and the JRC obtained national status.

26. List upcoming activities

- More CSC PhD’s and postdocs (with Wuhan roots) are expected in Delft the next couple of years (as continuation of the past tradition).
- In context of the new double degree PhD-programme, it is expected that new/ future PhD students at TU Delft are also interested in the collaboration with Wuhan.
- With the several submitted proposals (and more planned), more actual joint projects are expected to start in 2016/2017.
- Two-month visit of software developer Wu Wenhua (Wuhan) to TU Delft, department GRS is planned. After first jointly working at a distance on the development of software for the Sentinel-1 satellite data processing. The algorithms will be added to the TUD open source doris-processor (http://doris.tudelft.nl).
- In the context of the China-Netherland Agreement of Academic Exchange, Dr. Xuefeng Guan (LIESMARS, WHU) will be visiting scholar at GIS/ TUD for one-year from August 2015. In Delft he will be working on parallel and distributed geo-processing of spatial data.
- Two TUD MSc Geomatics students will (most likely) visit WHU/LIESMARS to do part of their education: Charlotte Duynstee and Jade Haayen (November 2015- March 2016).

27. Relevant publications

Publications related to Wuhan-Delft JRC (visitors, education)

- Lina Huang, Martijn Meijers, Radan Suba, and Peter van Oosterom
  Engineering web maps with gradual content zoom based on streaming vector data,
  In Press, Corrected Proof ISPRS Journal of Photogrammetry and Remote Sensing,
  Available online 6 January 2016, http://dx.doi.org/10.1016/j.isprsjprs.2015.11.011


- Radan Suba, Martijn Meijers, Lina Huang and Peter van Oosterom
  An Area Merge Operation for Smooth Zooming
  In: J. Huerta, S. Schade, C. Granell (Eds.); Connecting a Digital Europe Through Location and Place, Springer, 2014, pp. 275-293
  PDF file 753 KB
- Radan Suba, Martijn Meijers, Lina Huang and Peter van Oosterom
Continuous Road Network Generalization
PDF file 1566 KB

- Filip Biljecki, Hugo Ledoux, Jantien Stoter and Junqiao Zhao
Formalisation of the level of detail in 3D city modelling
PDF file 3920 KB

- Junqiao Zhao, Jantien Stoter and Hugo Ledoux
A framework for the automatic geometric repair of CityGML models
In: M. Buchroithner, N. Prechtl, D. Burghardt (Eds.); Cartography from Pole to Pole, Springer, 2014, pp. 187-202
PDF file 1544 KB

- Sisi Zlatanova, Liu Liu, George Sithole, Junqiao Zhao and Filippo Mortari
Space subdivision for indoor applications
PDF file 4050 KB

- F. Biljecki, J. Zhao, J. Stoter and H. Ledoux
Revisiting the Concept of Level Of Detail in 3D City Modelling
PDF file 2299 KB

- J. Zhao, H. Ledoux and J. Stoter
Automatic Repair of CityGML LOD2 Buildings using Shrink-wrapping
PDF file 4474 KB

- Junqiao Zhao, Jantien Stoter, Hugo Ledoux and Qing Zhu
Repair and generalization of hand-made 3D building models
PDF file 529 KB

- Shen Ying, Renzhong Guo, Lin Li, Peter Van Oosterom and Jantien Stoter
Construction of 3D Volumetric Objects for a 3D Cadastral System
In: Transactions in GIS Volume 19, 5, 2015, pp. 758-779, DOI: 10.1111/tgis.12129
PDF file 1383 KB

- Jantien Stoter, Peter van Oosterom and Hendrik Ploeger
The Phased 3D Cadastre Implementation in the Netherlands
PDF file 702 KB

- Rod Thompson and Peter van Oosterom
Validity of Mixed 2D and 3D Cadastral Parcels in the Land Administration Domain Model
Shenzhen, pp. 325-342
PDF file 239 KB

- Renzhong Guo, Shen Ying, Lin Li, Ping Luo and Peter van Oosterom
  A Multi-jurisdiction Case Study of 3D Cadastre in Shenzhen, China as Experiment using the LADM
PDF file 971 KB

- Shen Ying, Renzhong Guo, Lin Li, Peter van Oosterom, Hugo Ledoux and Jantien Stoter
  Design and Development of a 3D Cadastral System Prototype based on the LADM and 3D Topology
PDF file 1275 KB

- Renzhong Guo, Lin Li, Biao He, Ping Luo, Shen Ying, Zhigang Zhao and Renrong Jiang
  3D Cadastre in China - a Case Study in Shenzhen City
PDF file 1003 KB

- Xiang Zhang, Tinghua Ai, Jantien Stoter and Xi Zhao
  Data matching of building polygons at multiple map scales improved by contextual information and relaxation
PDF file 3412 KB

- Jantien Stoter, Xiang Zhang, Hanna Stigmar and Lars Harrie
  Evaluation in Generalisation
PDF file 1228 KB

- Xiang Zhang, Tinghua Ai, Jantien Stoter and Jingzhong Li
  Towards Cartographic Constraint Formalization for Quality Evaluation
  In: M. Buchroithner, N. Prechtel, D. Burghardt (Eds.); Cartography from Pole to Pole, Springer, 2014, pp. 89-101
PDF file 1793 KB

- Xiang Zhang, Tinghua Ai, Jantien Stoter, Menno-Jan Kraak and Martien Molenaar
  Building pattern recognition in topographic data: examples on collinear and curvilinear alignments
  In: Geoinformatica, Volume 17, 1, 2013, pp. 1-33
Link

- Xiang Zhang, Jantien Stoter, Tinghua Ai, Menno-Jan Kraak and Martien Molenaar
  Automated evaluation of building alignments in generalized maps
Link

- Xiang Zhang, Xi Zhao, Martien Molenaar, Jantien Stoter, Menno-Jan Kraak and Tinghua Ai
  Pattern classification approaches to matching building polygons at multiple scales
  In: M. Shortis, J. Shi, E. Guilbert (Eds.); ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume I-2, XXII ISPRS Congress, August-
Synthesis project 2013: DaRen, Students of MSc Geomatics (TU Delft) experiment with a 3D indoor navigation system for the Provincial Museum of Hubei in China, combining the newest techniques. DaRen is the first project from the Joint Research Centre of TU Delft and Wuhan University. More information:

- [http://darenproject.weebly.com/](http://darenproject.weebly.com/)
- **Geomatics Synthesis project 2013** (PDF, 5.43 MB)
- **Presentation BlueMark innovations** (PDF, 2 MB)
- **Presentation Geomatics students**

Presentations related to Wuhan-Delft JRC (Wuhan related visitors, education)

- Deren Li, **A Framework Design for the Chinese National Disaster Reduction System of Systems** (collegerama), 26 April 2012, TU Delft, MSc Geomatics Open Lecture Series.
- Qing Zhu, **Cutting-Edge Technologies of 3D GIS?** (collegerama), 27 April 2012, TU Delft, MSc Geomatics Open Lecture Series.
- Xuefeng Guan, The Integration of Vario-scale Data Generalization with Heterogeneous
- Lina Huang, WFS-Refinement extension for rapid transmission and adaptive visualization of vector data on the Web, 27 June 2014, GIS-technology lunch seminar presentation.
- Yan Zhou, Obtaining human moving traces from indoor surveillance video data, 4 September 2014, GIS-technology lunch seminar presentation.
- Yeting Zhang, Efficient large nD Data Management in DBMS, 4 September 2014, GIS-technology lunch seminar presentation.
- Qile Zhao, Development on high-precision GNSS/LEO satellite orbit determination: the latest Chinese satellite plan and its implication on scientific research, 22 April 2014, Seminar of GRS Dept.
- Yeting Zhang, Efficient Large Volume 5D Data Management in DBMS, 21 November 2013, GIS-technology lunch seminar presentation.
- Junqiao Zhao, Automatic Simplification Approaches for the Complex 3D Building Models, 16 August 2012, GIS-technology lunch seminar presentation.
- Hua Liu, In-memory spatial database based on key-value pair, 22 March 2012, GIS-technology lunch seminar presentation.
- Shen Ying, Incremental updating between scale-linked maps, 25 November 2011, GIS-technology lunch seminar presentation.
- Ying Shen, Valid Solid Construction, 6 June 2011, GIS-technology lunch seminar presentation.
- Ying Shen, Building 3D cadastral system based on 2D surveying plans with SketchUp, 14 January 2011, GIS-technology lunch seminar presentation.

Note: GIS-technology lunch seminar presentations are available at [http://wiki.tudelft.nl/bin/view/Organisation/OTB/GIS/LunchMeetings](http://wiki.tudelft.nl/bin/view/Organisation/OTB/GIS/LunchMeetings)

See also Appendix 4 – JRC Related Presentations.

28. Existing, expected or wishes for joint education development and or other agreements

Main targets for the near future, besides continuing with the excellent ‘business as usual’ (CSC PhD students, visiting postdocs and professors):

- conducting more cooperative projects, either as results of joint research proposals, or as results of proposal led by one partner, but involving the other partner and including educational projects/ assignments (Master thesis projects, MSc Geomatics synthesis project, etc.);
- have more PhD students entering the double degree programme (target for 2016 and 2017 is 4 new PhD students per year). After a long preparation and agreeing on the principles on the double degree PhD regulation at the August 2014 workshop in Delft, it is expected that the agreement will be signed by both partners in Wuhan on 11 March 2016;
- After exploring the possibility of the newly proposed (and to be accepted) Dutch educational law WHW and when done so with positive outcome, then establishing the double degree MSc (content, practical agreements). Crucial is to have an agreement on no-foreign fees. A realistic time frame would be to start in September 2017 with at most 5 TUD MSc students going to Wuhan and 5 WHU students going to Delft. When successful these numbers might be gradually increased; e.g. 10 in 2018. Important aspect is to explore which master programmes at the Wuhan side (various schools and LIESMARS) and which at the Delft side (Geomatics, GIMA, geo-track CitG) would be suitable for the double degree MSc.

- Together with the approval of National Chinese MOE status, WHU has started the International Academy of GeoInformatics (IAG-WHU). Supporting scholarships are expected from more broad sources including Ministry of Commerce China, CSC, NASG etc.

- With the approval of taking IAG-WHU as member of UN-GGIM Academic Network, the JRC is in a good position to explore the possibility to provide joint education services to member countries of UN-GGIM. This has started from WHU side with the first slide-show in UN-GGIM working meeting in NY on 12 Dec. 2015, via the introduction of JRC AB-member Pengde Li, who is one of co-chairs of UN-GGIM.

- With the National Chinese MOE status of the JRC, further supports from other Chinese government departments (NASG, MOST) are expected hereafter. The JRC is expected to get approval from MOST as a ministry-level platform for international cooperation on education and research on geospatial information science & technology.
Appendix 1 – Selection from JRC Wuhan-Delft Wiki Content

Note: to access the listed documents on the Wiki http://wiki.tudelft.nl/bin/view/Research/WDJRC/WebHome (the various hyperlinks to the mentioned pdf documents), an access account is needed as the Wiki contains internal/ confidential information not open to public.

Events: workshops, Advisory Board meetings

- Agreement_Wuhan-TU_Delft_final_09_11_2012.pdf: Agreement between Wuhan University (WHU), Wuhan, P. R. of China and Delft University of Technology (TU Delft), Delft, the Netherlands on the establishment of a “Wuhan University - TU Delft Joint Research Centre on Spatial Information” (CooperationWD_v12.pdf: Annex to Agreement)
- Plenary 12 November 2012
  - TUD0_vdBerg_final.pdf: Speech by Dirk Jan van den Berg, President of TU Delft
  - gong.pdf: Presentation by Jianya Gong (Wuhan Scientific Director WD-JRC)
  - TUD0_overview.pdf: Presentation by Peter van Oosterom (Delft Scientific Director WD-JRC)
  - SpatialInformation_WHU.pdf: Presentation by Huayi Wu (Wuhan University)
- Plenary 13 November 2012
  - OverviewGISprojectProposal.pdf: Overview GIS Group Project Proposal
  - OverviewGovProjectProposal.pdf: Overview Gov Group Project Proposal
  - OverviewGNSSprojectProposal.pdf: Overview GNSS Group Project Proposal
  - OverviewRSprojectProposal.pdf: Overview RS Group Project Proposal
  - OverviewPSGprojectProposal_v2.pdf: Overview PSG Group Project Proposal
- First Advisory Board, 21 January 2013
  - AB_WHU_DUT_JRC_draftagenda_meeting_21jan13_v2.pdf: Draft agenda of the First meeting of the Advisory Board, 21 January 2013
  - 20130404_AB_Meeting_Minutes.pdf: Minutes of first AB meeting, 21 January 2013
  - 20130404_AB_regulations.pdf: Regulations Advisory Board, version 21 January 2013
  - AB_NRSCC_WDJRC.pdf: Presentation by Xiaohan Liao, Director General, National Remote Sensing Centre of China
  - AB_Kadaster_WDJRC.pdf: Presentation by Kees de Zeeuw, Director, Kadaster International, The Netherlands
  - AB_Grontmij_WDJRC.pdf: Presentation by Li Bin, Director Grontmij, China
  - TUD_SpatialInformation_21jan13.pdf: Presentation by Peter van Oosterom on Spatial Information Research (and Education) at Delft University of Technology
  - AB-WHU_DUT_JRC_initial_topics_complete.pdf: Initial overview of proposed research topics Wuhan University - TU Delft Joint Research Centre on Spatial Information
- Second Advisory Board, 14 May 2013
  - 0_AB_TUD_meeting14may13_v3.pdf: Draft Agenda Second Wuhan-Delft JRC Advisory Board Meeting, 14 May 2013
  - 2_TUD_AB_14may13.pdf: WD-JRC and TU Delft brief overview: Peter van Oosterom
  - 4b_3D_things.pdf: Presentation 3D Geoë info (including Indoor GML) & crisis
management: Sisi Zlatanova

4c_2013_05_14_Presentatie_14_mei_Advisory_Board_meeting.pdf: Presentation Geo-info governance: Bas Kok
4d_GIS_t_AB_14may13.pdf: Presentation GIS technology (vario-scale/5D, LADM/3D cadastre): Peter van Oosterom
5a_Joint_Proposal_John.pdf: Presentation of First joint project proposal 'Collaborative Research on 3D Geographic Information Technology for Smart City': Junqiao Zhao
5b_Synthesis_project.pdf: Presentation of Plan for TU Delft MSc Geomatics synthesis project '3D multi-purpose indoor navigation application', Hubei Provincial Museum (Wuhan September/October 2013): Sisi Zlatanova
5d_Massimo.pdf: Presentation Optical observations: hydrology, climate and 3D terrestrial landscapes: Massimo Menenti (slides not used at meeting)
AB_TUD_meeting14may13_short_report_final.pdf: Short Report of the AB meeting at TUD on May 14-05-2013

Second Wuhan-Delft JRC Workshop, 19-20 August 2014 (TU Delft, OTB, Jaffalaan 9, Delft, the Netherlands)
0_AgendaWorkshopWDJRC_aug_13_v3.pdf: Agenda and list participants (workshop and 3rd advisory board)
0_WuhanDelftWorkshop_Photompression.pdf: photo
1_Opening_PeterB_Wuhan_OTB.pdf: Welcome by OTB, Peter Boelhouwer, Chair Department OTB – Research for the Built Environment, Faculty of Architecture and the Built Environment
2_WT-JRC_Overview2014-08-19.pdf: Summary of JRC and related results from Wuhan perspective (Jianya Gong)
3_DelftResults_FundingOpportunities.pdf: Summary of JRC and related results from Delft perspective - incl. research funding opportunities (Peter van Oosterom and Sisi Zlatanova)
5_WuhanDelftWorkshop_DoubleDegree.pdf: Double/dual degree PhD Wuhan-Delft (Karel Luyben)
7AB_Research_program_of_WHU.pdf: Research Programs of Wuhan University on Surveying and Mapping 2012-2016 (Jianya Gong)
7A_ResearchProgrammeGiTG_OTB.pdf: Research Programme (extract) Geo-information Technology and Governance, Department OTB Research for the Built Environment Faculty of Architecture and the Built Environment, Draft, October 2013
7A_Real_time_GIS___why_v3.pdf: Real-time GIS - Bridging the Future Trillion Sensors to Time-Critical Geospatial Applications (Huayi Wu)
7A_YING12288Shen_delft.pdf: 3D Cadastre: progress and challenges (Renzhong Guo, Shen Ying)
7A_ii-OnlineGen.pdf: On-line Map Generalization and Web Services Aiming at VGI Users (Tinghua Ai)
7A_ResearchProgrammeGiTG_OTBppt.pdf: Geo-information Technology and Governance Research Program 2013-2018 (Peter van Oosterom)
7B_Physical_and_Satellite_Geodesy_Research_Plan.pdf: Physical and Satellite Geodesy @ TU Delft Research Plan (Roland Klees)
7B_WHU-TU_Delft_Research_Centre_ -
Joint research activities

Physical and Satellite Geodesy (Roland Klees)

High-precision positioning for SAR scatterers: applications for railway monitoring (Liao Mingsheng, Ramon Hanssen, Chang Ling)

Lina Huang (back in China, presentation by Martijn Meijers): WFS-Refinement extension for rapid transmission and adaptive visualization of vector data on the Web

Reporting on research proposals, incl. practical agreements (who submits where/when)

Third Wuhan-Delft JRC Advisory Board Meeting, 20 August 2014 (TU Delft, the Netherlands)

Short Advisory Board meeting report, updated version 12 Sept'14 (Elfriede Fendel)

Summary of JRC and related results from Wuhan perspective (Jianya Gong), same document workshop

Reporting on research proposals, incl. practical agreements (who submits where/when), same document workshop

Joint Research Groups

- GeographicInformationSystems GIS
- GeographicInformationGovernance Gov
- RemoteSensing RS
- GlobalNavigationSatelliteSystems GNSS
- PhysicalSatelliteGeodesy PSG

Main Results

Continuation visiting staff and PhD's (mainly from Wuhan to Delft, and often with CSC funding; e.g. PhD student Yihao Wu and Xiang Guo, visiting professors Yeting Zhang and Lina Huang) and also for the next period more CSC funded staff and PhD's from China expected in Delft.

Several joint publications after above mentioned research visits: some already completed, but another part still expected in 'aftermath' of these visits.

Completed PhD-thesis with JRC support and joint supervision: Hamayun, Global Earth Structure Recovery from State-of-the-art Models of the Earth’s Gravity Field and Additional Geophysical Information, 30 June 2014, TU Delft. Supervisors: Prof. Dr.-Ing. habil. R. Klees (TUD promotor), Dr. P. Ditmar (TUD copromotor), Prof. Dr.-Ing R. Tenzer (Wuhan University, China, copromotor)

Besides this internal Wiki for communication, also an external website developed: http://jrc.tudelft.nl/spatial-information

Various joint research proposals prepared, one of which is submitted to MoST: Integrated Urban Intelligent Management Technology and its Applications based on 3D GeoInformatics (now on MoST waiting list 2015).

Visit of TU Delft connector, prof. Wieringa, to Wuhan in the context of the 120-year anniversary of the University, but also the opportunity to discuss the possibilities double of dual degree PhD agreements between the Universities. The TU Delft connector is in Delft also the chair of the 'Doctorate board'.

We are very proud of our TU Delft students for their MSc Geomatics Synthesis project '3D indoor navigation system for the Hubei Provincial Museum (Daren)', which was conducted in the fall 2013 during visit to Wuhan along with two teachers TUD (Sisi Zlatanova and Edward Verbree); http://darenproject.weebly.com and complete report on http://www.tudelft.nl/fileadmin/Files/tudelft/studeren/master/Geomatics/Synthese_project/G
Last week of 2014 WHU finished and submitted a proposal to the Chinese Ministry of Education about funding to support WHU-TUD joint centre. The proposal has passed the first round evaluation and will be further evaluated by the government (in the context of Chinese national policy to support international JRC’s).


TU Delft MSc thesis student Kaixuan Zhou visited Wuhan February-March 2015 for his research project 'Knowledge Based Regularization of Façade Reconstruction from Point Cloud' (see Exchange_report_Kaixuan_Zhou.pdf). Supervision by Ben Gorte (GRS, TUD) and Zhichao Zhang (School of Remote Sensing and Information Engineering, WHU).

Preparation of research proposal 'Integrated indoor/outdoor navigation among moving obstacles' by Zhiyong Wang/Sisi Zlatanova (TUD) and Prof. Xinyan Zhu and Mr. Qing Xiong (WHU); see plan preparation Zhiyong_Proposal_for_JRC.pdf and report of visit to Wuhan on 30/31 March 2015 Zhiyong_Report_for_visiting_Wuhan.pdf

Two research proposals ('3D Cadastre visualization and query interface' by Marian de Vries Open_Project_Application_Form_3DCadastre_interface_v4.pdf and 'Vario-scale representation of Shenzhen maps' by Martijn Meijers Open_Project_Application_Form_VarioScale_v3.pdf) submitted to the open project call of the Key Laboratory of Urban Land and Resources Monitoring and Simulation, Ministry of Land and Resources (located in Shenzhen, by Renzhong Guo, JRC AB-member). The vario-scale proposal approved and funded with 180000 RMB (2.Open_Project_Contract_v2_3.pdf).

Research proposal 'Unification of World Height Datum' (NSFC_agreement-Mar11-RK.pdf) to the National Science Foundation of China (NSFC) by Prof. Dr. WenBin Shen (School of Geodesy and Geomatics, WHU) and Prof. Dr.-Ing. habil. Roland Klees (GRS, TUD).

Research proposal 'Geo Big Data Generalization and Visualization' (Collaborative_Research_Agreement_v6.pdf and Whu_Delft_nsfc_proposal_2015_v6.pdf) to the National Science Foundation of China (NSFC) by Dr. Jingzhong Li/ Prof. Dr. Tinghua Ai/ Dr. Xiang Zhang (School of Resource and Environmental Sciences, WHU) and Prof. dr.ir. Peter van Oosterom (GISt, TUD).

Two month visit in 2015 of software developer Wu Wenhua (Wuhan). After first jointly working at a distance on the development of a software for the Sentinel-1 satellite data processing. The algorithms will be added to the TUD open source doris-processor (http://doris.tudelft.nl).

In the context of the China-Netherland Agreement of Academic Exchange, Dr. Xuefeng Guan (LIESMARS, WHU) will be visiting scholar at GISt/ TUD for one-year from September 2015. In Delft he will be working on parallel and distributed geo-processing of spatial data (CV-guanxuefeng-v3_20141226.pdf and TUD_letter_2015-_Guan-v2.pdf).

Two TUD MSc Geomatics students will visit WHU/LIESMARS to do part of their education: Charlotte Duynstee and Jade Haayen (November 2015- March 2016).
Appendix 2 – Scope of cooperation

(background document, as annexed to the MoU of 12 November 2012)

Background
After several earlier meetings and emails, on 17 November 2011, at TU Delft, The Netherlands, Cees Timmers, Prof. Peter van Oosterom, Prof. Li Lin, Dr. Shen Ying discussed the scope and possible format of cooperation between Wuhan and Delft in the field of geo-information. Similar applies to an already established cooperation in the field of geodesy. Cees Timmers did have two visits to Wuhan and further discussed the cooperation, before on 24 April 2012 there was a second meeting at TU Delft with participation from Prof. Deren Li, Prof. Qing Zhu, Prof. Ramon Hanssen, Prof. Roland Klees, Prof. Massimo Menenti, Dr. Sisi Zlatanova, and Prof. Peter van Oosterom. To date, the cooperation is perceived as successful, yet it remains ad-hoc and is limited to the occasional exchange of staff members. Since both universities have a strong reputation in these fields in their respective countries and considering our common interest, we agree that there is sufficient leverage and interest to develop a more structured cooperation between the following research groups at Wuhan University (WHU) and TU Delft (TUD), all active in the field of geodesy and geo-information:

- WHU’s School of Geodesy and Geomatics of WHU,
- WHU’s School of Resource and Environmental Science,
- WHU’s School of Remote Sensing and Information Engineering,
- State Key Laboratory of Information Engineering in Surveying Mapping and Remote Sensing (LIESMARS),
- GNSS Research Center of WHU,
- Department of Geoscience and Remote Sensing (GRS), Faculty of Civil Engineering and Geosciences (CiTG), TUD,
- GIS Technology section, OTB Research Institute for the Built Environment, TUD.
- Knowledge Centre Geo Information Governance, OTB Research Institute for the Built Environment, TUD.

Under the umbrella of a joint centre, various aspects of the proposed collaboration could be facilitated, such as the exchange of staff and students, joint supervision of PhD and postdoctoral research projects, the creation and development of training courses, and the organization of workshops.
Topics and modes of cooperation
Below is an initial list of possible topics and modes of cooperation in the field of geodesy and geo-information, and the required actions to arrive at such a strengthened cooperation:

1) The potential establishment of a joint centre for research (and training) located at Wuhan University, either as a virtual or physical entity
2) The centre can be started modestly and gradually develop to maturity alongside increasing (market) opportunities and available human resources (staff, students);
3) In the field of geodesy and geo-information, a variety of both applied and more fundamental research projects could be identified, formulated and jointly conducted;
4) In the field of geo-information, possible applied research topics could include:
   • 3D/4D Cadastre realization
   • Multi-scale/map generalization
   • Geo-database updating
   • Use of geo-information (technology) to better support Disaster Management
   • Governance of geo-information
   • Impact of data sharing
   • Assessment of Spatial Data Infrastructures (SDIs)
5) In the field of geodesy, possible research topics include:
   • Gravity field modelling
   • Mass transport in the Earth system
   • Geoid determination and vertical reference systems
   • Precise orbit determination of low Earth orbiting satellites
   • Surveying technology and positioning using GNSS systems
   • Mathematical geodesy and quality control
   • Remote Sensing technology, including optical, microwave and radar (InSAR) technology
   • Near-real-time monitoring technologies of infrastructure, railroads, buildings
   • Monitoring technologies for natural hazards such as seismic hazards, landslides, flooding, subsidence
   • Reference systems and geometric infrastructure
6) The research will be carried out mostly by PhD students and postdoctoral fellows, and, if time and opportunity permits, also by MSc students. The research will preferably be jointly supervised.
7) Staff exchange will be increased. TUD staff will regularly visit WHU for co-supervision, training, workshops, as well as meetings with stakeholders.
8) The financing of the centre is a crucial issue. Hence the importance of sourcing external funding from private entities, R&D institutes and national (CSC, ‘111’, NNSF, NOW) and local governments in China. A good example of the latter is Shenzhen’s interest in a “3D cadastre” application project.

Planning
Several persons of the involved participating organizations have come up with viable research ideas/projects with a (very) rough indication of duration, staffing and funding. This inventory should be further refined, completed and used as the basis for the future cooperation. The next step will be a joint workshop at WHU to discuss the inventory and conclude a shortlist of viable research projects. The workshop will be followed by separate meetings with potential stakeholders. At the end of the workshop, a Memorandum of Understanding (MoU) may be drafted providing details on the joint activities, as well as the proposed establishment of a joint centre.
Long term research goal: 5D geo-information and geodesy

The unique and very novel approach of geo-information modelling in five dimensions is the setting for the general long-term fundamental research agenda for the cooperation. Apart from three dimensions for geometrical representation and a fourth dimension for time, scale (level of detail) is introduced as fifth dimensional characteristic. Through a formal definition of geographic data in a conceptual 5D continuum, the data can be handled by one integrated approach assuring consistency across scale and time dimensions. The result is a conceptual full partition of the 3D space+time+scale space (i.e. no overlaps, no gaps) realised in a 5D data model implemented in a Database Management System (DBMS).

The more fundamental concepts of the 5D data models and data structures may be applied to solve the issues of redundancy and inconsistency caused by unconnected data sets about the same location at several scales and time periods. More applied research will be conducted to translate the 5D data approach to practical cases and will also show how the intermediate 3D models (2D+scale; 2D+time) and 4D models (2D+scale+time; 3D+time) already yield fundamental improvements compared to current independent management of 2D/3D multiscale and spatiotemporal data.

Geodesy and geodetic engineering including remote sensing, forms the complementary part of the long term research goals. Gravity, geometry and remote sensing are the key fields in this context. The desire to monitor and model the Earth’s gravity field, rotation, and figure in space and time is a core activity in geodesy. For instance, historically, the primary objects of physical geodesy (gravity field, geoid, height system) were modelled as 2/3-D fields in space. Individual models were compiled as static ones and characterized by a trade-off between the spatial coverage and spatial scale (i.e., global models contained information about largest spatial scales only, whereas high-resolution models were limited in space). The situation started to change in the last decade or two. The launch of satellite altimetry and dedicated satellite gravimetry missions, a wide usage of airborne observation techniques, development of efficient data fusion algorithms, and the advent of fast and cheap super-computers have led to a dramatic improvement in the resolution of global models and, furthermore, allowed temporal variations of the gravity field and geoid to be captured. This opens the door, in particular, to apply geodetic techniques for the observation of mass transport in the Earth’s system, which is of great interest for various Earth sciences, including climatology, continental hydrology, oceanography, etc. Nevertheless, a lot of efforts are still needed to reach the point when both static and time-varying features of the Earth’s gravity field and geoid are modelled globally, homogeneously, and with a high spatial resolution. A full-scale assimilation of geodetic measurements into models of various natural processes (e.g., hydrological models, models of ice dynamics, etc.) is another challenging task that still has to be solved.

Apart from gravity, the geometry-related part of geodetic science is developing rapidly with a multitude of GNSS systems (including Beidou and Galileo), a multitude of imaging radar systems (including Sentinel-1 and many X-band missions), and airborne and terrestrial laser scanning technology. Trends that can be recognized in this field are the system-of-systems approach, increased precision, reliability, and integrity levels, increased temporal sampling and extent, increased spatial resolutions and extent, and quick and easy availability of data. The abundance of data produced by all the methods above is expected to peak in 2013-2014, and will dramatically change the possibilities for monitoring and surveying, and therefore trigger a range of new applications of these techniques. At the same token, data processing demands in general, and dedicated algorithms and computing systems in particular, need to be further advanced to keep up with data availability. The mathematical background of the data processing demands needs to be further developed, and numerical capabilities including high-performance computing need to be improved. Application areas include reference systems and geometric infrastructure, natural hazards (seismic, landslides, flooding, subsidence) and the monitoring of crucial man-made objects such as transport infrastructure, water safety and buildings.
**Applied research opportunity: focus on 3D/4D Cadastres**

3D/4D cadastre is the best topic that we can push the cooperation on the short term. Real transactions of land space or property units promote the modelling and management of cadastral objects, both in 2D and in 3D with temporal stamps. Therefore, all aspects that include the scientific researches, techniques, applications of 3D GIS and 3D cadastre can be integrated together. And all parties (TUD, WHU, Shenzhen) could be involved in the joint centre under which TUD and WHU can conduct research studies, with the group at Shenzhen providing data, case studies and applications.

**Applied research opportunity: focus on 3D/4D indoor modelling, 3D positioning and 3D navigation**

Indoor modelling is rapidly gaining the attention of research communities in various aspects: fast and automatic creation of 3D models of existing buildings, conversion from Building Information Models, positioning and orientation, 3D navigation. TUD and WHU have been working independently on these topics already for years. The joint centre could be the place where the researchers can unite their efforts, exchange experience, research ideas and use cases and design frameworks for further research and developments. The cooperation in this relatively new field can rapidly result in new projects.

**Applied research opportunity: semantic enrichment of 3D/4D models**

Semantics aspects of geo-information is another topic that can push the cooperation at very short terms. Many data sets exist and are created (even 3D) but the thematic semantic of the data is purely represented (the explicit encoding of the meaning of the information; e.g. based on knowledge engineering tools, such as ontology). The data sets have nice appearance but no thematic semantic meaning, which makes their use limited. All the aspects of thematic semantic modelling can become a part of the research agenda of the centre: creating 3D models with semantics, enriching existing models with semantics, mapping/conversions between different models to obtain a model that is most appropriate to the goals of a specific application.

**Applied research opportunity: enhanced laser point cloud processing**

Currently airborne laser data is acquired at many locations at regional scale, while Laser Mobile Mapping Systems enable the acquisition of laser point cloud data at urban scale. These new data sets contain a wealth of information that could be extracted for urban applications, like facade and road inspection and street sign maintenance, ecological applications like tree and biomass inventories, but also for coastal management (dune and beach erosion, vegetation development) and flooding simulations. Still, successful application is often hampered by the lack of computationally efficient methods to handle point clouds consisting of millions of points. Therefore the centre could contribute to the development and adaption of methodologies aiming at the processing and storing of large quantities of point cloud data for real world applications.

**Applied research opportunity: Automation of city model reconstruction and change detection at different scales on the basis of aerial, terrestrial & mobile LIDAR data**

Context is the application of 3D cities models for modelling of urban climate. This would require acquisition, extraction and integration of data and information for different sensors and sources. Reconstruction of the 3 dimensional urban geometry, including buildings and trees, is needed for modelling the atmospheric boundary layer, as well as shadows, whereas 2.5D terrain is needed for runoff modelling. Information about absorption and reflection at surfaces of buildings and terrain, as well as retrieved biophysical vegetation parameters is input for models concerning radiation and energy balances.

**Applied research opportunity: Multi-scale modelling of mass transport in the Earth’s system**

Many processes in the Earth's system are associated with mass transport, such as the loss/gain of ice...
in the cryosphere, accumulation and depletion of continental water stocks, and isostatic adjustment, to name a few.
Techniques such as satellite radar/laser altimetry and gravimetry can be used to monitor such processes; however, each of these techniques is characterized by its own accuracy, resolution, and coverage in the spatial and time domain. No individual measurement type is capable of providing a sufficiently comprehensive picture of mass transport, but their combination can often result in new discoveries and insights. This project will seek to develop new methodologies to combine various geodetic measurements, constrained with a priori geophysical information, to better understand and model these mass transport processes across a range of spatial and temporal scales.

**Applied research opportunity: high-resolution high accuracy regional geoid models from fusion of various data sources**

Traditional methods of geoid determination are either Stokes-based methods or least-squares collocation techniques. In the context of geoid determination from many data sources, there is a need to develop methods, which can be adapted to different spatial coverages, signal content, and noise characteristics of the various data sets. The development comprises suitable parameterizations for gravity fields, which can be adapted to the spatially varying data distribution, statistical techniques for proper data weighting, and numerically efficient algorithms for parameter estimation.

**Applied research opportunity: Vertical system connection**

Many waters in the world lack an accurate and easily assessable vertical reference surface and a well-defined and accurate relation to the national, regional, and global terrestrial height systems. This project aims at providing such a surface and the necessary transformations required for the conversion between all common land and marine vertical reference surfaces. These goals would be realized through a combination of satellite, airborne, marine and terrestrial gravity data, radar altimeter data, water levels at on- and offshore tidal stations, and water levels from GNSS, with a hydrodynamic model. Based on a properly vertically referenced hydrodynamic model, new approaches to i) vertically connect islands and off-shore platforms with the mainland, ii) water level reduction for depth measurements, and iii) the vertical positioning of underwater vehicles will be developed.

**Applied research opportunity: regional sea level variations**

Mean sea level is currently rising by about 3 mm/yr and this rate is expected to increase as a consequence of global warming. At regional scales, however, sea level changes can be much larger than the global mean due to the effect of variations in the Earth's shape and gravity, of both natural and anthropogenic origin (e.g., earthquakes, deltaic processes, dams building, groundwater extraction). This project focuses on understanding regional sea level changes at different spatial and temporal scales, by combining geodetic measurements over open and coastal waters with measurements of crustal motion and geophysical models of solid earth deformation. As a result, we aim at separating the different contributors to sea level change in coastal areas, with special emphasis on distinguishing between climatic and anthropogenic sources, in order to improve the management of resources for coastal development and protection.

**Applied research opportunity: Advanced estimation of satellite orbits in the context of satellite gravimetry formations**

The primary space-borne technique to observe temporal variations of the Earth’s gravity field is low-low Satellite-to-Satellite Tracking (LL-SST): two satellites orbit the Earth as a formation, measuring minor variations of the inter-satellite distances. The quality of the resulting gravity field models depends, in part, on the accuracy of the computed satellite orbits. The primary goal of the project would be to develop new orbit determination algorithms tuned for satellite gravimetry formations (that would use, in particular, the LL-SST data). This is a continuation of an already long-standing fruitful cooperation between the Physical and Space Geodesy group at TUD and the GNSS
Research Centre at WHU.

**Applied research opportunity: Advanced Interferometric SAR techniques**

In this topic, the scientific investigations will focus on processing algorithms for imaging radar sensors such as ERS, ENVISAT ASAR, Sentinel-1, TerraSAR-X, COSMO-SkyMed, ALOS-2, and HJ-1C. Processing algorithms are the main engine to overcome current limitations of these sensors, and developments in Delft and Wuhan in this field can be used to develop the next generation of algorithms, able to cope with the ever increasing data volumes. This makes it now possible to apply successfully multi-image processing analysis for high resolution topographic measurement and land subsidence monitoring. In addition, cross-validation can be performed by comparison among results from different data sources.

**Applied research opportunity: Monitoring of natural and man-induced hazards**

China has always faced several important geohazards, such as earthquakes, flooding, landslides, and subsidence. In relation with the increased urbanization and population growth, the impact of these hazards will increase exponentially. This necessitates the use of geodetic and Remote Sensing techniques for risk assessment and mitigation. Space-geodetic techniques (GNSS and InSAR in particular) can be used to detect and monitor land motion related to such hazards. The recent Guest-professorship of prof. Hanssen at Wuhan University is an example of a long-lasting collaboration between the groups, but also the honorary professorship of prof. Teunissen dating back to the year 2000 shows further collaboration potential between the two universities. In this project we will investigate the geodetic-geophysical relations between observations and the physical phenomena (hazards) of interest.

**Applied research opportunity: New generation GNSS systems and methods**

In this program we will investigate the open scientific questions in relation to the new GNSS developments, e.g. related to Beidou and Galileo. From the perspective of mathematical geodesy studies will be performed on the aspects of precision, reliability and integrity. The combination of the different systems will play an important role in these studies.

**Applied research opportunity: Governance of Geo-information**

Vast amounts of geo-data have been and are constantly collected and processed in response to specific user needs. Nevertheless, much geo-data can be used for other objectives as well, with little or no need to re-collect or re-process it. Since the sharing of geo-data is considered to be in the general interests of society as a whole, from an environmental, social and economic perspective, there is an overall drive to increase the sharing by improving access, removing technical, legal and financial barriers and devising appropriate organizational structures. The impact of technological advances on the availability, access, and use of geographical information, and on the institutional setting within a Spatial Data Infrastructure, are key drivers in the development of SDIs. This also applies to the effects of societal and governance trends like (de)centralization, e-governance, outsourcing and rethinking of the role and size of public administration.

**Applied research opportunity: Impact of data sharing on SDI objectives**

Technology has provided new ways of sharing geoinformation among different organizations. A number of programmes at national (e.g. the Dutch e-government programme ‘Different Government’) and European level (in particular INSPIRE, the EC Public Sector Information (PSI) directive, GMES, Galileo and the EC Water Framework Directive) have made people – at least within the geoinformation sector – aware of the need for increased data sharing and improved access. The final legal outcomes of these programs are, however, quite limited in their prescriptive provisions. The Dutch laws regulating the use of base registers focus on applications within the government sector, and leave a wide range of options for the level of access by the private sector.
The INSPIRE directive only requires the free availability of search services, and free access to environmentally relevant geo-data for institutions of the European Commission. The extent to which data sharing is promoted may differ between Member States, raising the questions whether some Member States are more successful in meeting SDI objectives than others.

**Applied research opportunity: Assessment of SDIs**

Technological developments influence not only the availability of, access to and usability of geoinformation, but also the roles played by the public and private sectors and citizens in the geoinformation infrastructure. In the near future, geoinformation may become part of the infrastructure like water and electricity supplies, which are only noticed when they break down – as e.g. when people complain “the server is down” or “the map is not available” (Star and Ruhleder, 1996). This new infrastructural role for geoinformation might require re-assessment of not only the required data quality characteristics, but also the access policies accompanying the data. This all increasingly calls for the continuing development of SDI assessment frameworks.

**Representative on-going research projects at WHU**

1) National Natural Science Foundation of China “Differential updating and integration of multi-scale maps” (Shen YING, 2011.1-2013.12);
2) National Special Fund for Land Resource Scientific Research in the Public Interest. “Key techniques and applications of 3D cadastre” (Renzhong Guo, Lin LI, Shen YING, 2011.1-2013.12);
4) 3 year Key 863 project on “real time GIS (4D) for emergence response” started from Jan.2012 (Jianya Gong).
5) 5 year 973 project on “Spaceborne-AirBorne-Insitu integrated Earth Observation Sensor Web” started from Jan.2011 (Liangpei Zhang)
6) 5 year 973 project on “the precision processing of high resolution remote sensed data and the intelligent transformation of spatial information” started from Jan.2012 (Jie Shan)
7) 3 year Key 863 project on “remote sensed monitoring and crisis management of typical geological disaster” started from Jan.2012 (Qing Zhu)
8) 4 year Technology Support Program on “video GIS and holographic location map” started from Jan.2012 (Qing Zhu).
9) 5 year 111 project on “intelligent processing of geospatial information” (for international cooperation and exchange) started from Jan.2012 (Deren Li).

**Representative on-going research projects at TUD**

1) 5D data modelling (Vidi NWO STW-11300): 5 year project started in May 2011 including 2 PhD students, 1 postdoc and tenured staff (fundamental research on 5D modelling)
2) Vario-scale geo-information (OTP NWO STW-11185): 4 year project started in June 2011, including 1 PhD student and part-time postdoc (fundamental research on vario-scale maps, quite related to the 5D project).
3) Collaboration with Dutch Kadaster: since October 2009 Jantien Stoter has 50/50 appointment at Dutch Kadaster and TU Delft (no end date).
4) Crisis management topics (various PhD researchers started 2011, 4 year duration): ‘3D indoor "door-to-door" navigation approach to support first responders in emergency response’ (Liu Liu), ‘Integrating spatio-temporal data into agent-based simulations for emergency navigation support’ (Zhiyong Wang), and ‘Designing formal semantics of geo-information for disaster response’ (Amin Mobasheri).
5) 3D Spatial Infrastructure (NGPort Infra): 2 year project, start January 2012, fundamental research and prototype for 3D SII of Port Rotterdam considering information above and below surface (water) and BIM.
6) Simplification of digital terrain models using feature-based three-dimensional methods (OTP NWO STW-12217): 4 year project starting from June 2012, including 1 PhD student.


9) Designing a future mass transport observation system based on satellite gravimetry (supported by the Open Program of NWO): 4-year project, 1 Ph.D. student, started in Feb. 2011.

10) Multi-scale modelling of water resources in Northern China (supported by the Joint Scientific Thematic Research Programme of the NWO): 4-year project, 1 Ph.D. student, started in June 2011.

11) Earthquake deformation and gravity (supported by the Open Program of NWO): 3-year project, 1 postdoc, to be started in 2012.

12) Gravity changes at low spherical harmonic degrees: accurate determination and explanation of the driving mechanisms (to be executed by Mr. Yu Sun with the support by the CSC program): 4-year Ph.D. project, to be started in Sep. 2012.

13) Vertical Reference Frame for the Netherlands Mainland, Wadden Islands and Continental Shelf (NEVREF) (submitted for NWO STW funding): 4-year project, 2 postdocs

14) Applying level-1b data from the GRACE mission in hydrological modeling: a new concept of handling satellite gravimetry measurements (in preparation, to be submitted to the Open Program of NWO): a 3-year project, 1 postdoc.

15) Monitoring of Dams and Railroads in China, in relation to the Dragon-3 project (1 PhD, 2010-2014)

16) New processing algorithms for subsidence mapping (PhD Funded by Shell, 2009-2013)

17) CO2 sequestration monitoring using satellites. (PhD Funded by CATO-2, 2010-2014)

18) Urban city monitoring (PhD funded by Liander, 2009-2013)

**On-going research project WHU-TUD**

3 year Key 863 project on Developing operational data products on the terrestrial water cycle (Coordinator in China: prof. Qinhuo Liu CAS IRSA). Contacts WHU: Prof. Zemin Wang (School of Geodesy and Geomatics), TUD: Prof. Massimo Menenti.

The project plans to design and develop a software system, named Multi-Source Remote Sensing Production System (MSRSPS), to realize the functions for batch production of land surface variables. The system is composed of three sub-systems including multi-source remote sensing data pre-processing sub-system (M-RSPPS), land surface variables’ batch production sub-system (LSV-BPS), and data and task management sub-system (D&T-MSS). With the support of MSRSPS, we will provide the research team with land surface variables products for the period 2011 – 2014 in the designated research area. The products are further validated using the integrated satellite-airborne-ground experiments and the wireless sensor network observations considering the multi-scale spatio-temporal heterogeneity.

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1 Awarded and started in 2013.
**International context**

Important application domains under the umbrella of the cooperation are the use of geo-information in the context of crisis management, generalisation, the development of 3D (and 4D) Cadastre solution and governance of geo-information. All applied research themes have connections to international organizations: ISPRS (WG IV/8 - 3D Spatial Data Integration for Disaster Management and Environmental Monitoring, chair Dr. Zlatanova), FIG (joint commission 3 and 7 Working Group on 3D Cadastres, chair Prof. van Oosterom), EuroSDR (Commission Data Specifications, chair Dr Stoter), GSDI (past-president Kok and Chair GSDI Policy Advisory Think Tank, chair of legal and socio-economic committee Dr. Van Loenen), and EUROGI (past-president Kok). Prof. Guo and Dr. Ying are the Chinese members of the FIG WG on 3D Cadastres. TUD is member of the 3DIM OGC group responsible for the development of 3D spatial standards and several of the INSPIRE thematic working groups (TWGs). On the geodesy and remote sensing side international context is formed, e.g. by the Dragon-1, -2 and -3 program, and several case study based studies. The International Association of Geodesy (IAG) plays an important role in international corporation on Geodesy.

**Table overview of the cooperation**

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Participants from the WHU side

- Prof. Deren Li, LIESMARS,
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- Prof. Lin Li, School of Resource and Environmental Science,
- Prof. Tinghua Ai, School of Resource and Environmental Science,
- Dr. Shen Ying, School of Resource and Environmental Science,
- Renzhong Guo, WHU/Urban Planning, Land and Resources Commission of Shenzhen Municipality,
- Prof. Jingnan, Liu, Dean of the GNSS Research Center, Past President of Wuhan University, President of Kunshan Duke University.
- Prof. Li Tao, GNSS Research Center,
- Prof. Qile Zhao, GNSS Research Center,
- Prof. Jiancheng Li, Dean of the School of Geodesy and Geomatics.
- Prof Zhicai Luo, Director of the Institute of Geophysics and Geodesy (part of the School of Geodesy and Geomatics),
- Prof. Zemin Wang, School of Geodesy and Geomatics,
- Prof. Wonbin Shen, Institute of Geophysics and Geodesy,
- Prof. Caijun Xu, Institute of Geophysics and Geodesy,
- Dr. Yonghai Chu, Institute of Geophysics and Geodesy,
- Dr. Taoyong Jin, Institute of Geophysics and Geodesy,
- Dr. Jia Luo, Institute of Geophysics and Geodesy,
- Dr. Jianjun Wang, Institute of Geophysics and Geodesy,
- Dr. Haihong Wang, Institute of Geophysics and Geodesy,
- Dr. Zhengtao Wang, Institute of Geophysics and Geodesy,
- Dr. Xinyu Xu, Institute of Geophysics and Geodesy,
- Dr. Bo Zhong, Institute of Geophysics and Geodesy,
- Dr. Xiancai Zou, Institute of Positioning and Navigation Engineering (part of the School of Geodesy and Geomatics),
- Dr. Weisen Li, Deputy Director General National Administration of Surveying, Mapping & Geo-information (Note: The officials of the NASM are in principle interested to participate in this MoU),
- Fang Jingsheng, Deputy Director, Foreign Affairs Office, NASM,
- Wang Qian, Deputy Director General, NASM.
Participants from the TU Delft side

- Prof. Ramon Hanssen, GRS, CiTG, TUD,
- Prof. Roland Klees, GRS, CiTG, TUD,
- Prof. Massimo Menenti, GRS, CiTG, TUD,
- Prof. Peter van Oosterom, OTB, TUD,
- Prof. Peter Teunissen, GRS, CiTG, TUD,
- Dr. Sisi Zlatanova, OTB, TUD,
- Dr. Jantien Stoter, Dutch Cadastre/OTB, TUD,
- Dr. Tjeu Lemmens, OTB, TUD,
- Dr. Hugo Ledoux, OTB, TUD,
- Dr. Martijn Meijers, OTB, TUD,
- Associate Professor Bas Kok, Director Knowledge and Research Centre GI Governance, OTB, TUD,
- Programme Director MSc Geomatics, Edward Verbree, OTB, TUD,
- Dr. Bastiaan van Loenen, OTB, TUD,
- Dr. Andy Hooper, GRS, CiTG, TUD,
- Dr. Christian Tiberius, GRS, CiTG, TUD,
- Dr. Hans van der Marel, GRS, CiTG, TUD,
- Dr. Sandra Verhagen, GRS, CiTG, TUD,
- Dr. Ben Gorte, GRS, CiTG, TUD,
- Dr. Roderik Lindenbergh, GRS, CiTG, TUD,
- Dr. Pavel Ditmar, GRS, CiTG, TUD.
Appendix 3 - Advisory Board regulations

Wuhan University – TU Delft Joint Research Centre on Spatial Information
Advisory Board regulations, version approved on AB meeting on 21 January 2013

On November 12, 2012 a formal agreement was signed in Wuhan by the president of TU Delft and the Vice President of Wuhan University on the establishment of a joint research centre (JRC) on Spatial Information (SI).

The Centre is considered an important component of the international strategies of both universities as well as a representation of both parties’ intention to deepen the international cooperation between them. The Centre will be the platform where both parties can conduct various types of academic exchange, joint research studies, and joint application of projects by integrating their academic and research resources to build complementary advantages. It is also the operational entity, which coordinates and implements the existing and future activities of international cooperation between the two parties.

As per agreement, the organisation comprises the following levels: JRC Advisory Board; a Chinese and a NL Supervisor (presidents of WHU and TUD); a Chinese and a NL Scientific Director (Jianya Gong and Peter van Oosterom); a Chinese and NL coordinator (Lite Shi and Cees Timmers); Chinese and NL principal investigators (PIs) for the research topics.

Advisory Board (AB)
The general mandate of the AB is to give direction and to advise on both on-going and future JRC activities. This advise can be both explicitly asked for (reflection on plans presented by the Wuhan-Delft JRC) or not-asked for (own AB initiatives to direct and advise the Wuhan-Delft JRC). In addition, the AB provides a platform to strengthen inter-organisational co-operation and to facilitate operational contacts with other organisations active in the concerned fields.

More specifically the AB is expected to:
1) Review and advise on JRC research activities and research plans and, wherever possible and feasible, help remove any possible bottlenecks for continued smooth implementation.
2) Advise on matters transcending the actual implementation of research activities.
3) Identify possible spin-off activities in terms of research and training.
4) Provide information c.q. direction on new developments in the concerned fields from the member’s organisation perspective.
5) Whenever possible introduce JRC to other, relevant entities - and liaise between them - so as to strengthen JRC’s profile and enhance its activities by teaming up with those of other organisations.

Composition
The AB is chaired by Prof Deren Li (Wuhan University and member of both Academy of Sciences and the Chinese Academy of Engineering) will comprise of representatives of the following organisations:

From the Chinese side:
1) Xiaohan Liao, Director General, National Remote Sensing Centre of China (NRCC)
2) Pengde Li, Deputy Administrator, National Administration of Surveying, Mapping and Geoinformation of China (NASG)
3) Renzhong Guo, Deputy Director General, Urban Planning and Land Resource Commission of Shenzhen Municipality
From the NL side:

1) Gert Dral, Board of Directors, Grontmij
2) Kees de Zeeuw, Director, Kadaster International
3) Mart van Bracht, Director, Netherlands Organisation for Applied Scientific Research TNO

The AB-membership can be ended based on initiative of the AB-member or on the initiative of the Wuhan-Delft JRC (two options: new representative from same organization or no representative from organization).

The AB can be extended with new members based on the initiative from the AB-itself or on the initiative from the Wuhan-Delft JRC. Care should be taken that the composition of the AB remains sufficiently balanced, both with respect to number of members from China and NL, but also with respect to the topics covered.

**Other regulations**

The AB is established for the duration of the Wuhan-Delft JRC, which is according to the agreement on which the JRC is based a 5 year period starting from 12 November 2012 (and lasting until 12 November 2017) and to be further extended.

In case of disagreement within the AB on a specific topic (such as new membership proposals or specific advise to the Wuhan-Delft JRC), an explicit voting will be conducted and at least a 2/3rd majority of existing members is needed.

The chairman of the AB will be responsible for organising and conducting the meeting in close consultation with the two Scientific Directors. The Scientific Directors assign a Secretary to prepare AB meetings, co-ordinates the minutes and communicates findings to all relevant project parties. The two Scientific Directors assisted by the two Coordinators report to the meeting on pertinent issues regarding status and progress of activities.

The AB is expected to convene once every year alternatively in China and NL. In case of any special issues, the special AB meeting can be organized accordingly. The meetings are preferably to coincide with reciprocal visits of the Scientific Directors and Coordinators (China and NL) and/or scheduled close to international conferences.
Appendix 4 – JRC Related Presentations

Note: GIS-technology lunch seminar presentations are available at http://wiki.tudelft.nl/bin/view/Organisation/OTB/GISt/LunchMeetings

2015-06-25: Xuefeng Guan

Title: The Integration of Vario-scale Data Generalization with Heterogeneous Computing and Graph Database

Abstract: The vario-scale map generalization of massive spatial datasets is challenging. It is of great importance to research how to accelerate the generalization process to meet the practical efficiency requirements. Since currently the heterogeneous CPU/GPU systems become ubiquitous, the heterogeneous parallel computing provide a potential solution to speedup polygon collapse/merge and boundary simplification in map generalization. The data decomposition, task encapsulation, task scheduling, and load balance will be addressed during the parallelization. In addition, for smooth-zoom visualization or mixed-scale visualization, an efficient access to the converted tGAP dataset should be also considered. As the tGAP structure is a typical DAG and not a tree structure, mature graph databases can be used to store massive tGAP dataset. The database selection, storage schema, index building, and query interface will be resolved.

Slides: Introduction_research_plan_guanxuefeng_v2.2.pdf

2014-06-27: Lina Huang

Title: WFS-Refinement extension for rapid transmission and adaptive visualization of vector data on the Web

Abstract: The presentation will be a review of my research work during the past 1 year in GIST, OTB. In the previous research topological Generalized Area Partition (tGAP) structure has been designed to support smooth zoom and progressive transfer of vario-scale vector data. The focus was on server side and on converting sample data into the proposed vario-scale structure. My research work contributes to the ongoing vario-scale research by focusing on the client side. I will show how the tGAP structure can fit in current architectures and standardization efforts for map services to distribute maps on the internet. An extension of WFS-Refinement is put forward to reduce the amount of transferred data and provide efficient performance of vario-scale visualization. I will also introduce our other ongoing research to improve the tGAP data structure by multiple generalization processing.

Slides: lina_Huang_0627.pdf

2014-09-04: Yan Zhou

Title: Obtaining human moving traces from indoor surveillance video data

Abstract: In modern society, indoor surveillance system has been becoming popular and important for the purpose of public security, indoor navigation and other versatile applications. At present, it’s more and more convenient to collect video data from surveillance system. Meanwhile, a big challenge is to analyze these video data to get more useful information what we are interested in. In our research we worked on analyzing human moving trajectories across multiple discontinuous cameras based on the indoor video data. It’s focused on detecting human moving trajectories from video data and deducing potential human moving route inside a building by combination of 3D
indoor model and routing network. Besides these, our research also involved an optimal layout of multiple cameras. An optimal cameras setup algorithm is presented in order to observe the greatest monitor area with a given number of cameras or limited financial supports.


2014-09-04: Yeting Zhang
Title: Efficient large nD Data Management in DBMS
Abstract: This presentation will be a review of my researches done during my stay in OTB for nearly one year. I will share my experience and results on nD data management. The first one is nD R-tree based data cluster and index algorithm, which cluster geometry and topology data before packaging them into BLOB and building topology map between BLOB to speed up topology navigation among darts in BLOB. The second one is memory-restricted database building and updating algorithm which use dynamic-loading nD R-tree and local updating mechanism of geometry and topology to support large data set.


2013-11-21: Yan Zhou
Title: Spatial data dynamic balancing distribution for parallel spatial database
Abstract: Parallel spatial database has been becoming the inevitable trend of high performance spatial database development. The most research of parallel spatial database has focused on shared nothing architecture because of its availability, scalability and high cost performance ratio. However, spatial data unbalancing distribution can severely degrade the performance of parallel spatial database in shared nothing parallel environment. So the research of spatial data balancing distribution method has caused more and more interests, it means to allocate spatial data to different network nodes uniformly to obtain higher speedup performance of parallel spatial database. Data balancing distribution is one of the most important factors to improve the performance of parallel spatial database under shared nothing parallel architecture. Considering spatial locality and unstructured variable length characteristics of spatial data, this research includes two parts: static data partitioning strategy and dynamic data moving strategy. It based on Hilbert code which can keep spatial locality relationship between spatial objects to fulfill spatial data static balancing distribution status, and attain dynamic data balance based on the minimum spatial proximity to redistributing the spatial data. The proposed research aims to design a proper spatial data dynamic balancing distribution method for shared nothing parallel spatial database.


2013-11-21: Yeting Zhang
Title: Efficient Large Volume 5D Data Management in DBMS
Abstract: With the rapid development of measurement technologies such as remote sensing, we are facing more and more high dimension data. The typical sample is 5D Data (3D Geometry + time + scale), which is 3D Models in different Level of Detail and also in different time. 5D Data can support more advanced analysis functions such as slice in any direction. To use large volume high dimensional data efficiently, the management of both primitive and topology need be designed and implemented.

The proposed research aims to integrate high dimension primitive in large volume data sets into a DBMS based on G-maps. The research steps will be (1) select a suited DBMS that can support
quick data access. (2) Design reasonable database structure and data organization strategy based on data distribution. (3) Research high dimensional data index. (4) Design and implement efficient operator. (5) Build a prototype which having functions to help navigate and visualization. (6) Comparison in terms of speed/space for the different DBMS.


2013-03-22: Lei Niu
Title: A Survey of Wireless Indoor Positioning Technology for Emergency Responding
Abstract: The emergency responding needs positioning solutions to assist evacuation and rescuing operation. Therefore, we have to review the candidates for this purpose. The indoor positioning technologies and their application patterns show different levels of applicability in the emergency responding. According to the various demands of emergency responding, flexible localization solutions should be provided. We guide a first step to implement this concept in three pre-defined emergency scenes. At last, we conclude several key features of current emergency indoor positioning solutions and propose three future research topics
Slides: Indoor_positioning_for_emergency_routing_Alleen-lezen_Compatibiliteitsmodus.pdf

2012-11-29: Lei Niu
Title: Review of Grid Navigation Research in the Context of Emergency Building - Presentation at Gi4DM
Abstract: Grid-based navigation is one important approach for path finding besides the more often used network navigation. This paper makes a review of different approaches of grid navigation in the context of emergency routing, for grid navigation has many advantageous aspects and could be applied for indoor navigation in emergency routing. We also identify several future research directions for grid navigation applying in the emergency routing.

2012-08-16: Junqiao Zhao
Title: Automatic Simplification Approaches for the Complex 3D Building Models
Abstract: This presentation includes his PhD work of simplification of the complex 3D building models and the research of model repair. It is composed of following aspects:
- The simplification of facade model based on perceptual analysis
- The simplification of model structure based on morphology-based method
- The typification of tiled roof based on spline surface fitting and
- the preliminary research of validation and repair for hand-made 3D building models
Slides: 20120816_Lunch_seminar_John.pdf

2012-03-22: Hua Liu
Title: In-memory spatial database based on key-value pair.
Abstract: In common, vector model is based on OpenGIS specification and vector data is stored in
DBMS for GIS project, which don't meet some extremely demanding. The aim of this presentation is to focus on key-value pair vector model and in-memory database, which have much more performance and special features.

Slides: 22-03-2012.pptx

2011-11-25: Shen Ying
Title: Incremental updating between scale-linked maps
Abstract: Nowadays, multiple scale geo-databases have been building with NSDI and one key task focuses on continuous updating. Based on foundational map patterns and specifications, the corresponding relationships between different scale maps are established to reflect their relative functions. This paper presents the architecture of incremental updating, and delivers the methodology and implementation for automatic object match between two neighbor-scale maps. The approach uses the buffer overlay to generate two sets of candidate corresponding objects, and applies multiple-measure probabilistic match to identify the explicit correspondent object with the largest likelihood. Through table join many-to-many corresponding relationships can be determined. Detail analysis about the matching results are given and discussed in two maps of one same region with neighbor scales. The aim of map match is to find the corresponding objects in the source database, and propagate them to target-scale map and update the matched spatial objects with them, which provides a novel way to update the scale-linked maps automatically. A prototype is implemented to extract and publish the Incremental information.


2011-06-06: Ying Shen
Title: Valid Solid Construction
Slides: 2011-06-06-YingShen-ValidSolidConstruction.pdf

2011-01-14: Ying Shen
Title: Building 3D cadastral system based on 2D surveying plans with SketchUp
Abstract: This presentation presents a method for building a three dimensional cadastral management system from surveying plans with SketchUp. It concentrates on the geometric representation and topological consistent maintenance of 3D cadastral objects. In this system a complete topological model is built to express the body construction and spatial relationships among 3D property units. SketchUp is used to automatically construct 3D model with attributes and thematic information from 2D surveying plans. Spatial topological relationships and operations are analyzed with the programming and development of Ruby language. The resulting system can manage the 3D cadastral objects and manipulate them with spatial operations to support spatial analysis. Moreover, the presentation will deliver some problems about 3D cadastre we meet in actual applications in China.

Slides: 2011-01-14-Lunchmeeting-YingShen-3DCadastre.pdf
Appendix 5 – Presentations and participants 11 March 2016

Presentations mid-term assessment (slides included on next pages)

1. Peter van Oosterom/Gong Jianya: Overview report: Main results of first 3 years/plans for next 2 years of JRC
2. Sisi Zlatanova: Possibilities of new Dutch law, more supportive for International education e.g. Double degree MSc
3. Huaiyi Wu: Impact of new national Chinese status
4. Lina Huang: Example staff experiences in context of JRC
5. Charlotte Duynstee and Jade Haayen, TUD MSc Geomatics students at WHU: Example student experiences in context of JRC
6. Ramon Hanssen: Example of joint software development (DORIS)

Participants Delft University of Technology

- Prof.dr.ir. Peter Wieringa, Vice Rector, University Corporate Office/Executive board
- Krista Knopper MA, University Corporate Office/Strategic Development/Corporate Policy Affairs
- Prof.dr.ir. Peter van Oosterom, Faculty of Architecture and the Built Environment, Department OTB, GIS Technology Section/ Director JRC Wuhan-Delft from TU Delft
- Prof.dr.ir. Ramon Hanssen, Faculty of Civil Engineering and Geosciences, Department Geoscience & Remote Sensing
- Dr. Sisi Zlatanova, Faculty of Architecture and the Built Environment, Department Urbanism, 3D Geo-Information Section
- Dr. Pavel Ditmar, Faculty of Civil Engineering and Geosciences, Department Geoscience & Remote Sensing, Physical and Space Geodesy Section
- Dr. Zhyiong Wang, graduated PhD, Faculty of Architecture and the Built Environment
- Charlotte Duynstee, MSc Geomatics Student
- Jade Haayen, MSc Geomatics Student
Participants Wuhan University

- Prof. Fei Li, Vice President
- Prof. Deren Li, Academician of Chinese Academy of Sciences and Chinese Academy of Engineering, Chairman of Academic Committee of Wuhan University
- Prof. Jianya Gong, Academician of Chinese Academy of Sciences, Director, LIESMARS; Dean, School of Remote Sensing and Information Engineering
- Xuemeng Cheng, Director, Office of International Affairs
- Anna Luo, Vice Director, Office of International Affairs
- Xiaolv Liu, Deputy Director, School of International Education
- Li Zhang, Vice Director, Section of Cultivation, Graduate School
- Prof. Huayi Wu, Vice Director, LIESMARS
- Prof. Yaolin Liu, Dean, School of Resource and Environmental Sciences
- Prof. Yibin Yao, Dean, School of Geodesy and Geomatics
- Prof. Qile Zhao, GNSS Research Centre
- Dr. Lina Huang, School of Resource and Environmental Sciences
- Chen Zhang, Deputy Director, Section of International Relations and Partnerships, Office of International Affairs
- Qiong Li, Program Officer of the Admission Office, School of International Education
- Lite Shi, Director, Office of International Affairs, LIESMARS
- Lin Guan, Vice Director, Office of Graduate Studies, LIESMARS
Wuhan University - TU Delft Joint Research Centre (WD-JRC) on Spatial Information
21-3-2016

Jianya Gong and Peter van Oosterom, scientific directors JRC Overview report for JRC assessment 11 March 2016, Wuhan University, China
Very recently announced and to be awarded on 25 May 2016...

Motivation to collaborate

- The establishment of the ‘Wuhan University - TU Delft Joint Research Centre on Spatial Information’ (WD-JRC) in November 2012 was **not the start** of the collaboration
- Over more than a decade the various geo-groups have been collaboration, more or less at ‘ad hoc’ level

- The establishment of the WD-JRC is milestone in collaboration:
  1. Intensify both applied and more fundamental joint research
  2. Increase staff exchange
  3. Jointly organize international conferences/workshops
  4. More PhD and perhaps also MSc education
Purpose/nature of the Centre

- WD-JRC is operational entity coordinates and implements the existing and future activities between the parties in area’s:
  1. GIS
  2. Geo Information & Governance
  3. Remote Sensing & its applications
  4. GNSS
  5. Physical & Satellite Geodesy

- Seed funding (3 years): WUH 1.800.000 RMB + TUD € 252.000

- Start modestly, gradually mature alongside increasing opportunities and available human resources (staff, students)
Satellite Image Calibration using AHN-2
Involved

- **Wuhan University:**
  1. State Key Laboratory, LIESMARS
  2. School of Resource and Environmental Science
  3. School of Remote Sensing and Information Engineering
  4. School of Geodesy and Geomatics
  5. GNSS Research Centre
  6. School of Urban Design

- **TU Delft:**
  1. Department of Geoscience and Remote Sensing (GRS),
     Faculty of Civil Engineering and Geosciences (CiTG)
  2. OTB, Faculty of Architecture and the Built Environment:
     • GIS Technology section and
     • Knowledge Centre Geo Information Governance;

WD-JRC Organization

- **Supervisors:** Youmei Feng, Dirk Jan van den Berg
  \(\rightarrow\) overall strategic guidance

- **Scientific Directors:** Jianya Gong, Peter van Oosterom
  \(\rightarrow\) in charge, responsible for all activities

- **Coordinators:** Huayi Wu/Lite Shi, Cees Timmers/Elfriede Fendel
  \(\rightarrow\) coordination, communication and administrative issues

- **Primary Investigators (PIs):** list of Wuhan and Delft prof’s
  \(\rightarrow\) responsible for proposals and actual research

- **Advisory Board:** chair, Deren Li and 6 external members
  \(\rightarrow\) independent reflection on results and future plans of JRC
Advisory Board

- Composition, chair Deren Li, 6 external members:
  1. Xiaohan Liao (National Center of Remote Sensing of China, MOST)
  2. Pengde Li (State Bureau of Surveying and Mapping)
  3. Renzhong Guo (Shenzhen Land and Plan Administer Commission)
  4. Gert Dral (KuiperCompagnons, past Grontmij)
  5. Mart van Bracht (TNO)
  6. Kees de Zeeuw (Kadaster)

- provide suggestions: topics/funds

- AB meetings: jan’13, may’13, aug’14
Summary of JRC results (1/2)

- Continue: staff/PhD exchange/visiting profs (Hua Liu, Yeting Zhang, Lina Huang, Lei Niu, Yan Zhou, Xuefeng Guan,…)

- In addition the following results:
  1. Formulation Workshop Wuhan University - TU Delft, 12-13 nov’12
  2. Communication: created Internal Wiki and External website
  3. Advisory board meetings organized: 21 jan’13, 14 may’13,
  4. MSc Geomatics synthesis project at Wuhan for 3D indoor navigation system for the Provincial Museum of Hubei (DaRen), fall’13
  5. Visit of TU Delft vice-rector, prof. Wieringa, to Wuhan in the context of the 120-year anniversary, also discuss double/dual degree PhD
  6. TUD PhD with JRC support and joint supervision (Klees/TUD, Tenzer/WHU) completed: Hamayun, 30 jun’14
  7. Second Wuhan-Delft JRC workshop, 19-20 August 2014, TU Delft

Summary of JRC results (2/2)

- and more:
  8. TUD MSc thesis student Kaixuan Zhou visited Wuhan, early 2015. Supervision by Ben Gorte and Zhichao Zhang
  9. Wuhan students visited TUD: Yihao Wu and Xiang Guo
  10. Variety of research proposals created, submitted and some awarded (e.g. vario-scale Shenzhen)
  11. Open source satellite data processing software Doris by TUD, and WHU contributions (during visit of Wu Wenhua)
  12. Two TUD MSc Geomatics students now visiting Wuhan: Charlotte Duynstee and Jade Haayen (nov’15-mar’16)
  13. First double degree PhD students together with Wuhan started: Mengshi Yang (supervisors: Ramon Hanssen and Liao Mingsheng), Mingxue Zheng (supervisors: Huayi Wu and Peter van Oosterom)
JRC workshop in Delft, August 2014 agreed on jointly supervised PhD
Communication: Wiki, private

Communication: website, public
Synthesis project 2013
(TUD MSc students)

Synthesis projects
• Second year MSc Geomatics: 2 months
• Work in a group on a real topic
• Apply knowledge from 1st year courses
• Report and present

An excellent cooperation!
• Operational system (prototype)
• Discussions with PhD students
• Publications of results in 3-4 papers
• Further ideas over common research
Synthesis project 2013

• The overall goal is a 3D multi-purpose indoor navigation application for the Hubei Provincial Museum
  • 3D data by Wuhan
  • Wifi positioning system by Wuhan
  • 3D data model by TUDelft
  • 3D visualisation on mobile by TUDelft

• Supervisors: Edward Verbree, Qing Zhu, Sisi Zlatanova, Xinyan Zhu, Haojun Ai, Kehua Su, Liang Huang, Qing Xiong, Xiao Xie, Weiping Xu, Taizhou Li, Tao Hu and more

TUD MSc Geomatics students @WHU
Charlotte Duynstee & Jade Haayen
Joint publications

Joint publications

- J. Zhao, H. Ledoux and J. Stoter
  Automatic Repair of CityGML LOD2 Buildings using Shrink-wrapping

- Junqiao Zhao, Jantien Stoter, Hugo Ledoux and Qing Zhu
  Repair and generalization of hand-made 3D building models

- Shen Ying, Renzhong Guo, Lin Li, Peter Van Oosterom and Jantien Stoter
  Construction of 3D Volumetric Objects for a 3D Cadastral System
  In: Transactions in GIS Volume 19, 5, 2015, pp. 758-779, DOI: 10.1111/tgis.12129

- Jantien Stoter, Peter van Oosterom and Hendrik Ploeger
  The Phased 3D Cadastre Implementation in the Netherlands

- Rod Thompson and Peter van Oosterom
  Validity of Mixed 2D and 3D Cadastral Parcels in the Land Administration Domain Model

- Renzhong Guo, Shen Ying, Lin Li, Ping Luo and Peter van Oosterom
  A Multi-jurisdiction Case Study of 3D Cadastre in Shenzhen, China as Experiment using the LADM

- Shen Ying, Renzhong Guo, Lin Li, Peter van Oosterom, Hugo Ledoux and Jantien Stoter
  Design and Development of a 3D Cadastral System Prototype based on the LADM and 3D Topology

- Xiang Zhang, Tinghua Ai, Jantien Stoter and Xi Zhao
  Data matching of building polygons at multiple map scales improved by contextual information and relaxation

- Jantien Stoter, Xiang Zhang, Hanna Stigmar and Lars Harrie
  Evaluation in Generalisation

- Xiang Zhang, Tinghua Ai, Jantien Stoter and Jingzhong Li
  Towards Cartographic Constraint Formalization for Quality Evaluation
  In: M. Buchroithner, N. Prechtel, D. Burghardt (Eds.); Cartography from Pole to Pole, Springer, 2014, pp. 89-101

- Xiang Zhang, Tinghua Ai, Jantien Stoter, Menno-Jan Kraak and Martien Molenaar
  Building pattern recognition in topographic data: examples on collinear and curvilinear alignments
  In: GeoInformatica, Volume 17, 1, 2013, pp. 1-33

- Xiang Zhang, Jantien Stoter, Tinghua Ai, Menno-Jan Kraak and Martien Molenaar
  Automated evaluation of building alignments in generalized maps

- Xiang Zhang, Xi Zhao, Martien Molenaar, Jantien Stoter, Menno-Jan Kraak and Tinghua Ai
  Pattern classification approaches to matching building polygons at multiple scales

Joint publications

- Renzhong Guo, Lin Li, Biao He, Ping Luo, Shen Ying, Zhigang Zhao and Renrong Jiang
  3D Cadastre in China - a Case Study in Shenzhen City

- Xiang Zhang, Tinghua Ai, Jantien Stoter and Xi Zhao
  Data matching of building polygons at multiple map scales improved by contextual information and relaxation

- Jantien Stoter, Xiang Zhang, Hanna Stigmar and Lars Harrie
  Evaluation in Generalisation

- Xiang Zhang, Tinghua Ai, Jantien Stoter and Jingzhong Li
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  Automated evaluation of building alignments in generalized maps

- Xiang Zhang, Xi Zhao, Martien Molenaar, Jantien Stoter, Menno-Jan Kraak and Tinghua Ai
  Pattern classification approaches to matching building polygons at multiple scales
Joint publications

  To Localise or to be Localised with Wifi in the Hubei Museum?
  In: S. Zlatanova, G. Sithole (Eds.); ISPRS Acquisition and Modelling of Indoor and Enclosed Environments,
  Cape Town, December 2013, pp. 31-35

- Q. Xiong, Q. Zhu, S. Zlatanova, L. Huang, Y. Zhou and Z. Du
  Multi-dimensional Indoor Location Information Model
  In: S. Zlatanova, G. Sithole (Eds.); ISPRS Acquisition and Modelling of Indoor and Enclosed Environments,
  Cape Town, December 2013, pp. 45-49

- W. Xu, M. Kruminaite, B. Onrust, H. Liu, Q. Xiong and S. Zlatanova
  A 3D Model Based Indoor Navigation System for Hubei Provincial Museum
  In: S. Zlatanova, G. Sithole (Eds.); ISPRS Acquisition and Modelling of Indoor and Enclosed Environments,
  Cape Town, December 2013, pp. 51-55

- S. Zlatanova, G. Sithole, M. Nakagawa and Q. Zhu
  Problems in Indoor Mapping and Modelling
  In: S. Zlatanova, G. Sithole (Eds.); ISPRS Acquisition and Modelling of Indoor and Enclosed Environments,
  Cape Town, December 2013, pp. 63-68

  Validation of static gravity field models using GRACE K-band ranging and GOCE gradiometry data.

  The static gravity field model DGM-1S from GRACE and GOCE data: computation, validation and an analysis of
  GOCE mission’s added value.

- Many presentations at WHU, TUD, and elsewhere
- More in publications and presentations pipeline...

Just yesterday
Looking forward… realistic opportunities

- The National Chinese MOE status for the next three years (2016-2018) of the JRC even further raises the academic ambitions
- Self assessment report, item B.15: ‘Special Note: the research funding system is restructured in China from 2016, and will have a leap on funding international collaborative activities’
- New Dutch educational law (WHW) will enhance international collaborations, possibilities for double degree MSc programme
- Higher numbers of jointly supervised PhD students
- Attract more research funding on both sided using JRC strengths
- Further collaboration (see afternoon session): research and possible education/training (summer schools, UN-GGIM network)
- Next AB-meeting, option Geospatial World Forum, may’16
- Make public version self assessment report (add short summary)
Wuhan-Delft JRC, Research topics
Geodesy & Remote Sensing

1. Direct use of GNSS phase and code measurements of LEOs to estimate the Earth’s gravity field
2. Improved methodology for monitoring the time-varying gravity field using data of GRACE/GRACE-FO & SWARM satellites
3. Height system unification and connection
5. Fully Automatic 3D city modelling from AHN-2: exchange of experiences
6. Real-time indoor registration and modelling using range cameras (eg. Kinect)
7. High-precision positioning for SAR scatterers: applications for railway monitoring

Wuhan-Delft JRC, Research topic
Geographic Information Systems

1. Seamless Integration of Outdoor & Indoor 3D Modeling and Navigation for Critical Infrastructure Protection
2. Large-scale Spatiotemporal Geographic Process Simulation for Time-critical Applications – Real-time GIS
3. Big geo-data generalization and visualization
4. 3D Registration / Administration
Also today...

- Our TU Delft colleagues Bekkering & Tieben
- Collaboration with Wuhan Municipality WLSP (city planning, land resources)
- Mapping Wuhan past & present 1870-2013
- Alternative for this afternoon ;-(
Importance of internationalisation

• Beneficial:
  • Acquiring knowledge, skills and professional competencies
  • Valuable for personal development and personal identity

• Evaluation of joint (double, multiple) education has been positive:
  • More profiling
  • High quality of education
  • More efficiency (more variations in the curriculum)
  ⇒ Strengths in the concurrence with other educations

• In Netherlands: 25 joint degrees (14 with international institutions)
• 2012: 1200 students did a joint program
Obstacles for joint degree in the Netherlands

European consortium for accreditation (ECA):
Joint programme: “an integrated curriculum coordinated and offered jointly by different higher education institutions and leading to a (double/multiple or joint) degree” => one degree joint degree

• Tuition fee (registration, distribution)
  • Student pays a tuition fee to every university
• Process of creating a joint-degree education
  • Learning goals
  • Periods and presence of students
  • Total period for education

Proposal for changes in the Law

• https://zoek.officielebekendmakingen.nl/kst-33840-3.html

• in Dutch, 16 January 2014
Changes 1/2

a) Possible to have joint organised education or thesis research.
b) Education given by NL-NL universities leads to one joint degree
c) Education given by NL-IN universities leads to one or more degrees
d) NL-IN should sign an obligatory agreement about
   - tuition fees,
   - registration and
   - the procedure for giving degree
e) In case of NL-NL, all universities are responsible to the law
f) In case of NL-IN, NL university is responsible for compliance with the (Dutch) law.

Changes 2/2

h) The student is obliged to stay registered in the NL university during the entire period of study (to be able to use all facilities)
i) The student will not pay double tuition fee
   - Fee by the NL university and no fee or very law by IN
   - Fee by the IN university and no fee or very law NL
   - Fee is paid only for the period when the student visit the University

Consequences:
- NL university will not get money for student registration from the government if no fee is paid in NL
- Student registration will be not depended on tuition fee
- NL university will have to share
Opportunities

- The law will change
- What would be the benefit for the two universities
  - Options to go in depth of some topics (profiles)
  - Stimulate exchange of students and teachers
- Start with small groups (3+3)
- The opinion of students
- The experiences with the joint degree with TUM
- Discuss the structure of the programme
  - 2-3 years
  - Tuition fees
  - .....
Some Latest Policies China, and its Possible Impacts on WHU-TUD JRC

Wu Huayi, Prof., Ph.D.  
Wuhan University  
Feb. 11th 2016  
wuhuayi@whu.edu.cn

Outline

1. Some New Policies and Trends
2. WHU-TUD JRC Strategies
3. What Are in Progress?
1 Some New Policies and Trends

**Before 2015**

- National Key Basic Research and Development Program (973)
- National high technology research and development program (863)
- National Key Technology Support Program (Various Ministries)
- International Science and technology cooperation project (MOST)
- National Science Foundation of China (NSFC) (including bi-lateral, China-EU etc.)
- Programs from various ministries, large companies, local governments
- 111 Plan / Thousand Talents program ……
- ……

**After 2015**

- Natural Science Foundation of China (NSFC)
- Key State Science and Technology Projects
- Key Research Tasks (CFP now)
- Technology Innovation Seeds
- Funding for Research Base and Talents

**Joint Research Center**

**International Exchange**

**Project-based International Cooperation**
1 Some New Policies and Trends

Big Science Projects and Programs

The world largest spherical radio telescope

Diameter: 500m

Scientific Research Centers

5+5 years
200-400 Million / 10 years
CFP released by NSFC
1 Some New Policies and Trends

International Jointly Research Center

3+n years
Managed by MOE

2 WHU-TUD JRC Strategies

- Scientific Research Center
- Bi-lateral Cooperation
- China-EU cooperation
- Identify Potential Topics
- Natural Science Foundation of China (NSFC)
- Key State Science and Technology Projects
- Key Research Tasks
- Technology Innovation Seeds
- Funding for Research Base and Talents
- International Collaborative Joint Lab
2 WHU-TUD JRC Strategies

Big Science Projects and Programs

- International Academy on Geoinformatics, WHU
- UN-GGIM Academic Network

3 What are in progress ...

International Collaborative Joint Research Lab on Geoinformatics
3 What are in progress ...

International Academy of GeoInformatics, WHU

UN-GGIM Academic Network

3 What are in progress

- Natural Science Foundation of China (NSFC)
- Key State Science and Technology Projects
- Key Research Tasks
  - 3D Modeling and Indoor Navigation
  - Global Mapping
  - Global Natural Resources Monitoring
  - Geospatial Big Data
  - Disaster Management
- Technology Innovation Seeds
- Funding for Research Base and Talents
Thank You!

whu_igeo@163.com
My visit in TU Delft
(July 2013 ~ June 2014)

Lina Huang
Department of Cartography and Geographic Information Engineering
School of Resource & Environmental Science, Wuhan University
11 March 2016

Content overview

- Work at OTB
- Main achievements
- Further cooperation at SRES
Work at OTB

• The research team
  • Peter van Oosterom (supervisor)
  • Martijn Meijers (postdoc)
  • Radan Šuba (PhD student)
  • Other members (e.g. Wan Muhd Hairi bin Wan Ab Karim, exchange student from Malaysia)

Work at OTB

• Research content:
  WFS-Refinement extension for rapid transmission and scale adaptive visualization of vector data on the Web

• Publications:
  - Radan Šuba, Martijn Meijers, Lina Huang, and Peter van Oosterom. Gradual transition of areal objects for smooth zooming, 17th AGILE.
  - Radan Šuba, Martijn Meijers, Lina Huang, and Peter van Oosterom. Continuous Road Network Generalization, 17th ICA Workshop.
  - Lina Huang, Martijn Meijers, Radan Šuba, and Peter van Oosterom. Engineering web maps with gradual content zoom based on streaming vector data, ISPRS Journal of Photogrammetry and Remote Sensing, in press
Work at OTB

- Other cooperation (STW projects)
  - 5D data modelling project
    2D+scale
  - Vario-scale geo-information project
    Web-client prototype, vario-scale transfer
    merge algorithms, smooth merge (‘zipper’)

Main achievements

- WFS-Refinement extension for rapid transmission and adaptive visualization of vector data on the Web

- Aim: efficient vario-scale vector data transmission

Current solution:
Transmission of LoDs (vector pyramid)  
Transmission of Vario-scale data
Previous research on vario-scale date structure (tGAP)

The size of LoDs: 115GB with around 540k polygons

The size of tGAP table: 503MB (including face and edge data) with around 191k faces

UK sample from the Corine dataset

Transmission using tGAP structure

-- Reused the local data
Transmission using tGAP structure

-- the vario-scale refinement

(e) 1:512412
(1:512412→1:1362694)
Edge: reused 4, new: 39

(f) 1:1362694
Face: reused 0, new: 13

(g) 1:1447722 ∈ [1:1362694, 1:512412]
(1:1362694→1:1447722)
Edge: reused 55, new: 0

(h) 1:1447722 ∈ [1:1362694, 1:512412]
Face: reused 15, new: 0

For initial map request
For map panning and zooming
Web-client prototypes

Layer view

Map view

Data connection (using Geoserver & postgreSQL on web side.)

Scale bar (plugin A,B,C)

http://varioscale.bk.tudelft.nl/demo/

Lina Huang, Martijn Meijers, Radan Šuba, and Peter van Oosterom. Engineering web maps with gradual content zoom based on streaming vector data, ISPRS Journal of Photogrammetry and Remote Sensing, in press
Further cooperation

- Ongoing research
  - improved cartographic aspects of tGAP/vario-scale
  - vario-scale representation and the usability (eye-track)

- Scientific publications

- Planning new project
  - Major International(Regional) Joint Research Project
    (Tinghua & Peter)

Experience at TU Delft

- A very conducive working environment for scientific research
- Friendly staffs and colleagues
- Excellent facilities
- Near to the office building and City Hall (5 minutes, 2 minutes)
- Interesting bicycles and clean sky
Thank you for your attention

• Wuhan University
  School of Resource and Environment Science (SRES)
  Department of Cartography and Geographic Information Engineering

• Dr. Lina Huang
  linahuang@whu.edu.cn
Background

Charlotte Duynstee

Jade Haayen

• Bachelor of Architecture, Urbanism and Building Sciences
• Master Geomatics TU Delft
• Electives of our master program at Wuhan University
Our experience

Delft – Lunch break
Wuhan – Lunch break

Our experience

- Cultural differences
- Registration at international office (campus card ready for use, no waiting time of 2 months)
- Jack and Jinglin great help
- Accommodation is good
- Facilities are good
- Work space
- Internet is unstable
- Teachers are very helpful
<table>
<thead>
<tr>
<th>Course</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensing Technologies</td>
<td>Dr. Ir. M.J.P.M. Lemmens</td>
</tr>
<tr>
<td>GIS and Cartography</td>
<td>H. Ledoux</td>
</tr>
<tr>
<td>Python Programming (elective)</td>
<td>Dr. Ir. B.M. Meijers</td>
</tr>
<tr>
<td>Positioning and Location Awareness</td>
<td>Ir. E. Verbree &amp; Dr. Ir. S.C. van der Spek</td>
</tr>
<tr>
<td>Spatial Decision Support for Planning and Crisis Management</td>
<td>Dr.ing.S.Zlatanova &amp; P.Nourian Ghadi Kolaee</td>
</tr>
<tr>
<td>Geo Database Management Systems</td>
<td>Prof. Dr. Ir. P.J.M. van Oosterom &amp; Drs.C.W.Quak</td>
</tr>
<tr>
<td>3D Modelling of the Built Environment</td>
<td>Dr. Ing. S. Zlatanova &amp; P.Nourian Ghadi Kolaee</td>
</tr>
<tr>
<td>Geo-datasets and Quality</td>
<td>Dr. J.E. Stoter</td>
</tr>
<tr>
<td>Geo-information Organisation and Legislation</td>
<td>Dr. Ir. B. van Loenen</td>
</tr>
<tr>
<td>Geo Web, Sensor Networks and 3D-GeoVisualisation Technology</td>
<td>Prof. Dr. Ir. P.J.M. van Oosterom &amp; Drs. M.E. de Vries</td>
</tr>
<tr>
<td>Synthesis project</td>
<td>Ir. E. Verbree &amp; Dr. Ir. S.C.van der Spek</td>
</tr>
</tbody>
</table>

**TU Delft**

- Wide range of different aspects within the field of Geomatics
- No Geomatics bachelor
- Students have wide range of backgrounds
- For each course big assignments, focus on applying the theory of the course
- Learning how to work on assignments with a group
Wuhan University – LIESMARS

<table>
<thead>
<tr>
<th>Course</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Navigation</td>
<td>Xiaoji Niu</td>
</tr>
<tr>
<td>Principle of Photogrammetry</td>
<td>Dr. John Trinder</td>
</tr>
<tr>
<td>Space Geodesy</td>
<td>Jizhang Sang</td>
</tr>
<tr>
<td>Principle and Application of Remote Sensing</td>
<td>Dr. Tsehaie Woldai</td>
</tr>
<tr>
<td>Signal Processing and Analysis</td>
<td>Bin Luo</td>
</tr>
</tbody>
</table>

Wuhan University

- More indebted on some specific topics within Geomatics. (for example the mathematics of Remote Sensing and Photogrammetry)
- Almost all students have background in the Geomatics field
- Small assignments/exams every week; focus on theory handled in the lectures
- Mostly individual assignments
TU Delft

• Wide range of topics

• No Geomatics bachelor, students have wide range of backgrounds

• Big assignments, focus on applying the theory of the course

• Learning how to work on assignments with a group.

Wuhan University LIESMARS

• More indebt on some specific topics

• Almost all students have background in the Geomatics field

• Small assignments/exams every week; focus on theory handled in the lectures

• Mostly individual assignments

Recommendations

• 3 year double degree master program:
  – First yearTU Delft
  – Second year Wuhan University
  – Third year graduation

• More information for the TU Delft students about what to expect in Wuhan
  – Campus card
  – Map of the Wuhan University campus, that points out where you need to be:
    • International Registration Office (including a guide of what the students can expect and what they need to prepare for the registration)
    • LIESMARS
    • The Blue building for classes
    • International students Dormitory
    • Where to go in Wuhan for living supplies

• More information for the Wuhan students about what to expect in Delft
  – Campus card
  – Map of the TU Delft university of where you need to go
Expectations for double degree

TU Delft Geomatics ➔ Wuhan University

• More mathematics
• More indebt on specific topics with the field of Geomatics
• More geoscience and geodesy courses/topics

Wuhan University ➔ TU Delft

• Wider field of different aspects of Geomatics, for example
  – Emergency management
  – Geo-information Organisation and Legislation
  – Dataset and quality
• Learning how to work on assignments in a group
謝謝  -  Thank you
Collaborative research in InSAR by Wuhan University and TU Delft

Ramon Hanssen

Joint Research Center evaluation, Wuhan 11-03-2016

Mengshi Yang, Ling Chang, Pooja Mahapatra, Freek van Leijen, Prabu Dheenathayalan, Sami Samiei-Esfahany, Ece Ozer, Floris Heuff, Gert Mulder, David Levelt, Hans van der Marel

Dynamic DEM

MC Cuenca, R Hanssen, A Hooper, M Arikan Surface deformation of the whole Netherlands after PSI analysis Fringe 2011
The Dynamic DEM

Elevation + Velocity
Activities Wuhan-Delft

- Teaching TUD@WHU (Teunissen) since 1998
- Teaching TUD@WHU (Hanssen) since 2010
- 2012-2015: Hanssen guest professor WHU
- 2012-02-27/03-02: Hanssen teaching WHU
- 2012-04-26: MoU meeting Deren Li, Liao Mingsheng
- 2013-06-03/09: Dragon 3 symposium Pmo
- 2014-05-19: Dam monitoring project Shenzhen (with Li Tao, WHU)
- 2014-05-21: Wuhan plenary seminar
- 2014-05-22/23: Integrated course on SAR interferometry, Wuhan
- 2014-05-26: Dragon-3 project meeting Chengdu
- 2014-05-30: Connection with Southwest Jiaotong
- 2014-06-01: JRC workshop in Delft
- 2014-10-18: ESA training course Nanchang
- 2014-10-24: Crustal Dynamics Institute Beijing
- 2014-10-25: Chinese IUGG key note presentation
- 2015-04-21/23: Wuhan PhD supervision
- 2015-06-22/26 Dragon 3 symposium
- 2015- : Hanssen guest professor WHU
- 2015-09-01: start Yang as PhD in Delft
- 2016-01-04 preparatory visit Dragon-4 project proposal
- 2016-01-29: submission Dragon-4 proposal
- 2016-03-08: Seminar LIESMARS
- 2016-03-09: Seminar Wuhan, CAS, Inst. Geodesy & Geophysics
- 2016-07-04/08: Dragon 3& 4 symposium Wuhan

Example “Risk” map  (**risk** to be defined)
Events: Rail infrastructure

-16.5 mm/year
5.5 cm in 3 year

Point properties:
Point ID: L1415207742
Linear: -16.5 mm/yr
Height: 2.6 m
Quality: 0.75
From layer: r_t_data_bsd_bsd_bsd

Events: Rail infrastructure

Qinghai-Tibet railway
People involved in InSAR

- **Wuhan**
  - Prof. Liao, Mingsheng, LIESMARS
  - Prof. Li, Deren, LIESMARS, (Lead Investigator Dragon 4 project)
  - Prof. Li, Tao, GNSS Research Center
  - Prof. Balz, Timo, LIESMARS

- **Wuhan/ TU Delft**
  - Ms. Yang, Mengshi
  - Mr. Wu, Wenhao
  - Ms. Qin, Xiaqiqing (tbd)
  - 1 PhD via Dragon-4

- **TU Delft**
  - Prof. Hanssen, Ramon
  - Dr. Chang, Ling
  - Dr. Van Leijen, Freek; Mr. Mulder, Gert

- **Other**
  - Prof. Ding, Xiaoli, HKPU
Future collaborative work

1. Joint research focus: ‘Positioning for InSAR’
2. Software development:
   a) TUD & WHU: joint development of a Sentinel-1 ‘TOPS’ processing module for Doris (Wu Wenhao, Li Tao, Gert Mulder, Freek van Leijen, Ramon Hanssen)
   b) WHU: development and sharing of ‘staring-spotlight Synthetic Aperture Radar interferometry’ module in Doris. Stereo SAR functionality (Timo Balz)
   c) TUD & WHU: beta testing and stress testing. (Applying tests on the same test areas) (Wi, Li, Balz, Mulder, Leijen, Hanssen)
   d) TUD: Doris general update
3. PhD research of ms. Mengshi Yang (sandwich-PhD) (Hanssen, Liao)
4. Landslide detection: Analysis of corner reflector data (Lu, Hanssen)
5. Testing radar transponders in combination with GNSS receivers (Li, Hanssen)
6. Dragon-4 project (Balz, Hanssen, Liao, Chang, Ding)
7. TBD: follow-up PhD research by ms. Xiaoqiong Qin (to be further discussed with prof. Liao)
### Dragon-4 joint project

**Dragon 4 Project**

- **ID**: 32278

<table>
<thead>
<tr>
<th>Title</th>
<th>Three- and Four-Dimensional Topographic Measurement and Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Dragon 4</td>
</tr>
</tbody>
</table>

#### Lead Investigator 1

<table>
<thead>
<tr>
<th>Last name (Family name)</th>
<th>Li</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name (Given name)</td>
<td>Deren</td>
</tr>
<tr>
<td>Title</td>
<td>Prof.</td>
</tr>
<tr>
<td>Institution</td>
<td>State Key Lab. of Info. Eng. in Surveying, Mapping and Remote Sensing</td>
</tr>
</tbody>
</table>

**Second Lead Investigator**

- Prof. Fabio Rocca
  - Dipartimento di Elettronica ed Informazione Politecnic di Milano
  - fabio.rocca@polimi.it
  - Research deliverables:
    - DEM/DSM validation tool as open-source for blind validation (responsible: Balz, Haala & Reinartz)
    - Long-term overview over the surface motion (responsible: Liao)
    - Near real-time surface motion estimation (responsible: Hanssen)
    - Validation of the surface motion (responsible: Balz)

---

**Dragon-4 project**

Research packages to be undertaken by young scientists:

- Long term overview of the surface motion (Qing, Xiaojie - PhD student at LIESMARS) **(Delft)**
- Geolocation and absolute positioning (Yang, Mengshi - PhD student LIESMARS and TU Delft)**(Delft)**
- Sentinel-1a data processing (Wu, Wenfeng Wu - PhD student WHU GNSS)**(Delft)**
- Estimation and elimination of the atmospheric and orbital effects (Gert Mulder - PhD student TU Delft)**(Delft)**
- Quality description and control (Sami Estahany, PhD student TU Delft)**(Delft)**
- DEM error adjustment, coregistration optimization and InSAR post-processing (a PhD to be started at HKPU)**(Delft)**
- Recursive updates, deformation modeling and hypothesis testing (a PhD project to be started at TU Delft)**(Delft)**
- NRT deformation monitoring (exact title tbd) (a PhD project to be started at TU Delft)**(Delft)**

Prof. Hanssen is going to visit Wuhan University on a yearly basis for teaching, financed by the Wuhan Guest professorship grant and the Wuhan-TU Delft JRC. We additionally propose two visits of Prof. Hanssen to HKPU in the framework of the NRT project.

Prof. Liao plans to visit TU Delft in 2016 for one month preparing the joint research work in Dragon and improving the co-supervision of the visiting PhD student Yang, Mengshi. This will be financed by the CSC special funding for PhD supervisors.
Dam monitoring

Ascending orbit

Descending orbit

 TU Delft
 Challenge the future

Dam monitoring

Ascending orbit

Descending orbit

 TU Delft
 Challenge the future
‘Absolute’ InSAR velocities

- Transponders mechanically connected to GPS stations

Appendix 6 – Double degree PhD agreement

Agreement for Joint Supervision and double degree of Doctoral Research between Delft University of Technology and Wuhan University.
AGREEMENT FOR JOINT SUPERVISION AND DOUBLE DEGREE OF DOCTORAL RESEARCH BETWEEN DELFT UNIVERSITY OF TECHNOLOGY AND WUHAN UNIVERSITY

Delft University of Technology, located in Delft, represented by Vice Rector Prof. Peter Wieringa, authorized by the Chairman of the Board for Doctorates, also Rector Magnificus of the Executive Board, Professor K.C.A.M. Luyben, hereinafter referred to as Delft University of Technology (TU Delft), address: Stevinweg 1, 2628 CN Delft, The Netherlands

And

Wuhan University, located in Wuhan, represented by its Prof. Fei Li Vice President authorized by the President, Professor Xiaohong Li, hereinafter referred to as WHU, address: Wuhan University, 129 Luoyu Road, Wuhan, P. R. China.

Sharing the common will to develop academic and scientific cooperation between the two institutions by fostering mobility among Doctoral candidates within the framework of existing inter-university agreements ¹;

Agree as follows:

Article 1: General, duration

There will be a joint supervision with regard to the joint research project, the preparation for the doctoral thesis and Doctoral Education of Doctoral candidates mentioned in the Appendix.

From TU Delft side, the total duration to obtain a doctoral diploma is nominally four (4) years or subject to the agreement between two Doctoral supervisors. From the WHU side, the study period for a Doctoral candidate should be at least for three (3) years and at most six (6) years.

Article 2 Duration at both universities

The time during which the candidate is working on the thesis will be divided in time approximately equally between TU Delft and WHU in Wuhan.

¹ See Model agreement Academic and Scientific Cooperation Agreement between Delft University of Technology and the partner University or Universities.
Article 3 Regulations of both universities

The preparation of this doctorate will be performed in compliance with legislation of both universities, including the Delft University of Technology Doctorate Regulations and Implementation Decree 2014 and the WHU Handbook of Regulations on Graduate Study.

Article 4 Supervisors

The candidate will carry out the research work under the supervision of a designated supervisor from each of the partner universities as stated in appendix.

The Board for Doctorates of the TU Delft appoints the supervisors. They will act as doctoral research supervisors and comply with the Delft University of Technology Doctorate Regulations. Both supervisors are tasked with monitoring the quality of the education. A daily supervisor may be appointed to carry out these tasks.

The powers and duties of a doctoral research supervisor as defined in the current Dutch and Chinese legislations will be undertaken jointly by the two supervisors.

Article 5 Doctoral committee

The supervisors referred to in Article 4 shall both be members of the doctoral evaluation committee as Doctoral supervisors. Besides these supervisors two (2) professors of Delft University of Technology and up to a maximum of two (2) professors of WHU may be appointed as members of the doctoral committee, of which at least one (1) member from each institution should be independent. At least one of the professors of WHU should be at present during the defense. In accordance with the Delft University of Technology Doctorate Regulations in total at least four (4) members of the doctoral committee should be independent. The Rector Maginificus is chairing the defence committee during the defence.

From the WHU side, the total number of committee members is seven (7). This committee shall elect a president among themselves, and the Doctoral supervisor shall not be the president. The defense should be kept on record by the Graduate School of WHU.

Article 6 Registration and fees

Once the competent authorities have signed their agreement, and subject to legislation on doctoral studies in force in each country, the Doctoral candidate will register at both contracting universities, which both waive their tuition fees. If the doctoral candidate who undertakes this double degree program discontinuous his or her study, he or she shall terminate study at TU Delft and WHU at the same time.
Article 7 Doctoral Education Programme
The candidate will follow a Doctoral Education Programme, composed and approved by the two universities, consisting of:

- Discipline related skills
- Research related skills
- Generic skills

in line with the guidelines and policy of the Graduate School and Doctoral Education of Delft University of Technology and the WHU Handbook of Regulations on Graduate Study.

The candidate is under obligation to finish the Doctoral Education Programme before defending his or her dissertation in public.

Both supervisors are responsible to see that the candidate meets the requirements of this Doctoral Education Programme. An agreement between the candidate and the supervisors will be signed, see the Appendix.

Article 8 Thesis
The Doctoral candidate will write the thesis in accordance with the thesis writing specifications of each university. An English version with an abstract in Dutch is needed to apply the degree of Doctor of TU Delft, with an abstract in Chinese is needed to apply the degree of Doctor of WHU.

Article 9 Acknowledgement in thesis
The Doctoral candidate shall acknowledge the contributions to the supervisions of the joint doctoral research in the doctoral dissertation thesis.

Article 10 Examination, defence
At the oral examination, i.e. during the defence ceremony, the Doctoral candidate will defend the thesis in the English language and will give an oral summary in the English language prior to the defence. The doctoral candidate who meets the degree requirements of WHU first conducts thesis defence at TU Delft with approval from WHU. The second defence will be performed at WHU. The dissertation and defense requirements should be consistent with those of the Wuhan University.
Article 11 Formal requirements thesis

Procedures concerning the format, number of copies and mode of submission of the thesis will be in compliance with legislation of both universities and should in any case be negotiated with and agreed by the Board for Doctorates of Delft University of Technology and Degree Evaluation Committee of WHU.

Article 12 Double degree

In compliance with legislation in force in each country, and based on the official report drawn up after the examination, the degree of Doctor will be conferred by WHU on the candidate.

Likewise, the degree of Doctor will be conferred on the candidate by the Board for Doctorates of Delft University of Technology.

Article 13 Diploma, certification

Two Doctoral Diplomas will be issued by each of the partner universities separately.

A diploma Supplement will be drawn up and contains a comprehensive summary of the joint supervision, Doctoral Education Programme, Doctoral Evaluation Committee and location where the defence took place. The diploma supplement will be drawn up by the supervisors and signed by the chairman of the Board for Doctorates.

The Doctor will receive a certificate from the TU Delft Graduate School as evidence of the Doctoral Education. The form of such a certificate shall be determined by consultation of the partners.

A certified copy of the Doctoral Diploma will be provided in the English language.

Article 14 Intellectual property

Legal protection of the subject of the thesis, together with its publication, development and protection of the results of the research carried out at the two laboratories by the candidate will be in compliance with the specific procedures of each of the countries involved in this agreement or subject to the agreement between two doctoral supervisors specified in the appendix.
Article 15 Social security

Throughout the duration of this protocol, the candidate will be covered by the following social security systems:

- Urban Residents Basic Medical Insurance whilst in Wuhan, China.
- The Netherlands’ Social Security system whilst in the Netherlands, through the European Health Insurance Card.
- Personal insurance

Article 16 Salary (if applicable)

The candidate will be paid a salary or will receive a scholarship.

Article 17 Joint supervision agreement for each Doctoral candidate

For each Doctoral candidate, the supervisors from both universities and Doctoral candidate have to sign a research agreement as in the appendix.

Delft University of Technology

(signature) Vice Rector

Date: 11/03/2016

Wuhan University

(signature Vice President)

Date: 11/3/2016
APPENDIX: DOCTORAL EDUCATION PROGRAMME BETWEEN
DELFT UNIVERSITY OF TECHNOLOGY,
WUHAN UNIVERSITY
AND DOCTORAL CANDIDATE (NAME).............

Article 1 Research Area, supervisors and specification of time

The specific area of research is (name area of research) ....................................................
at the department of (name department) .................................................................
at Delft University of Technology
and at the department of (name department) ..........................................................
at Wuhan University ...........................................................
The preliminary title of the doctoral candidate’s research project is: “..............................
.................................................................................”

Supervisors:
For Delft University of Technology
(name doctoral research supervisor) .................................................................
(Contact details) ........................................................................................................

For Wuhan University .............................................................
(name doctoral research supervisor) .................................................................
(Contact details) ........................................................................................................

Specification of time ......................................................................................................

Article 2 Obligations Doctoral candidate

The candidate will follow a Doctoral Education Programme, composed and approved by the two
universities, during his research work, in line with the guidelines and policy of the Graduate School
and Doctoral Regulations of Delft University of Technology. The candidate is under obligation to
finish the Doctoral Education Programme. The Cultivation Program can be individually applied to the
Graduate School of Wuhan University.
Article 3 Tasks supervisors

Both supervisors are tasked with monitoring the quality of the education. A daily supervisor may be appointed to carry out these tasks.

Both supervisors are responsible to see that the candidate meets the requirements of this Doctoral Education Plan.

Additional tasks:

WHU will require Doctoral candidate to do the following additional tasks to get the double Doctoral degree:

- Finish all the learning tasks and meet the requirement for course credits in accordance with the Doctoral Education Programme of WHU.
- Meet the requirement for publication which is specified in the Wuhan University Academic Publication Regulations for Applying Doctorate before applying the thesis review.
- Successfully pass the thesis defense.

Delft University of Technology

(name and signature doctoral research supervisor)
I have read this agreement of double degree and agree with its contents.

Wuhan University

(name and signature doctoral research supervisor)
I have read this agreement of double degree and agree with its contents.

The Doctoral candidate:
I have read this agreement and agree with its contents.

Date:

(signature Doctoral candidate )