Earth Sciences

Faculty of Earth and Life Sciences
VU University Amsterdam

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This report was finalized on 6 February 2013.

Report on the bachelor's programme Earth Sciences and the master's programmes Earth Sciences and Hydrology of VU University Amsterdam

This report takes the NVAO's Assessment framework for limited programme assessments as a starting point.

Administrative data regarding the programmes

Bachelor's programme Earth Sciences

Name of the programme:	Earth Sciences
CROHO number:	56986
Level of the programme:	bachelor's
Orientation of the programme:	academic
Number of credits:	180 EC
Specializations or tracks:	Solid Earth, Earth Surface, Geoarcheology (until 2014)
Location:	Amsterdam
Mode(s) of study:	full time
Expiration of accreditation:	31 December 2013

Master's programme Earth Sciences

Name of the programme:	Earth Sciences
CROHO number:	66986
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	Palaeoclimatology and Geo-Ecosystems, Applied Environmental Geosciences, Earth Sciences and Economics, Archaeometry, Landscape Archaeology, Solid Earth.
Location:	Amsterdam
Mode of study:	full time
Expiration of accreditation:	31 December 2013

Master's programme Hydrology

Name of the programme:	Hydrology
CROHO number:	60807
Level of the programme:	master's
Orientation of the programme:	academic
Number of credits:	120 EC
Specializations or tracks:	Hydrogeology, Ecohydrology (until September 2011 when it became Hydrology
Location(s):	Amsterdam
Mode(s) of study:	full time
Expiration of accreditation:	31 December 2013

The visit of the assessment committee Earth Sciences to the Faculty of Earth and Life Sciences of VU University Amsterdam took place on 18 and 19 September 2012.

Administrative data regarding the institution

Name of the institution:	VU University Amsterdam
Status of the institution:	publicly funded institution
Result institutional quality assurance assessment:	applied (pending)

Quantitative data regarding the programmes

The required quantitative data regarding the programmes are included in appendix 5.

Composition of the assessment committee

The committee that assessed the bachelor's programme Earth Sciences and the master's programmes Earth Sciences and Hydrology consisted of:

- Prof. M.A. Herber (chair), professor of Geo-Energy, University of Groningen, the Netherlands;
- Prof. M. Landrø, professor of Applied Geophysics, NTNU Tronheim (Norwegian University of Science and Technology), Norway;
- Prof. J.W. Hopmans, professor of Vadose Zone Hydrology, University of California (Davis), USA;
- Prof. Emeritus D.E. Walling, hydrologist/geomorphologist, University of Exeter, UK;
- Drs. R.L. Prenen, Msc, independent educational advisor;
- M.M. Cazemier (student member), master's graduate of Earth Sciences, Hydrology and Water Quality, Wageningen University.

The committee was supported by dr. Willemijn van Gastel, who acted as secretary.

Appendix 1 contains the curricula vitae of the members of the committee.

Working method of the assessment committee

Preparation
After receiving the critical reflection, the project manager checked the quality and completeness of the information provided. After approval, the critical reflection was forwarded to the committee, in both printed form and digitally. In addition, the chair of the committee selected a total of 15 theses for the bachelor's programme 10 theses of the master's programme in Earth Sciences and 6 theses of the master's programme Hydrology that was assessed (see appendix 7). The selected theses were read by the committee.

Before the site visit the project manager created a draft programme for the interviews (see appendix 6). The draft programme was discussed with the chair of the committee and the

coordinator of the educational institute. As requested by QANU, the coordinators of the programmes carefully composed a select and representative panel for all interviews.

Site visit
During the initial meeting at the start of each site visit, the committee members discussed among themselves their findings regarding the critical reflection and the theses. They also discussed their task and working methods and the proposed domain-specific requirements (see appendix 2).

During the site visit, interviews were held with representatives of the programme, students, staff members, the Education Committee, the Examining Board and a student adviser. A consultation hour was scheduled to give students and staff of the programmes the opportunity to talk to the committee. No requests were received for the consultation hour.

The committee used part of the final day of the site visit to discuss the assessment of the programmes and to prepare a preliminary presentation of the findings. The site visit concluded with an oral presentation by the chairman of the general assessment and several specific findings and impressions of the programme.

Report
After the site visit the project manager wrote a draft report based on the committee's findings. The draft was first commented upon by the committee members and then sent to the faculty to check for factual irregularities. All comments made by the faculty were discussed with the chair of the committee and, if necessary, with the other committee members. After revision, the report became official.

Decision rules
In accordance with NVAO's Assessment Framework for Limited Programme Assessments (as of 6 December 2010), the committee used the following definitions for the assessment of each individual programme, both of the standards and the programme as a whole.

Generic quality
The quality that can reasonably be expected in an international perspective from a higher education bachelor or master programme.

Unsatisfactory
The programme does not meet the current generic quality standards and shows serious shortcomings in several areas.

Satisfactory
The programme meets the current generic quality standards and shows an acceptable level across its entire spectrum.

Good
The programme systematically surpasses the current generic quality standards across its entire spectrum.

Excellent
The programme systematically clearly surpasses the current generic quality standards across its entire spectrum and is regarded as an international model.

Summary judgement

This report provides the findings and considerations of the Earth Sciences committee on the bachelor's programme Earth Sciences and the master's programmes Earth Sciences and Hydrology at the Vrije Universiteit Amsterdam (VU). The committee's assessment is based on information in the critical reflection, interviews during the site visit and a selection of theses.

In general, the committee concludes that the programmes in Earth Sciences succeed in offering students insight in the whole domain of Earth Sciences, whereas the Hydrology master's programme focuses on a niche in this system that is unique for the Netherlands. The committee was impressed by the curriculum of the Hydrology master's programme because it is closely in line with its aims and intended learning outcomes. The committee concludes that the main points to pay attention to are the justification for offering much fieldwork in the bachelor's programme, the viability of the master's programme in offering so many tracks and so much electivity, and plans for maintaining the quality of the programme during upcoming changes and uncertainties concerning the curriculum, intake, retiring staff and merging with the counterparts of the University of Amsterdam.

Standard 1: Intended learning outcomes
The *bachelor's* and *master's* programmes Earth Sciences and the *master's programme Hydrology* at the VU have, as other academic programmes of Earth Sciences, the planet Earth as the object of study, its genesis and its quality of life. These sciences are strongly interdisciplinary, with interaction between various factors, such as humans, fauna, relief, soil, water, lithology, atmosphere, hydrosphere and vegetation. Knowledge is gathered about its origin, current and former composition, and structure and the processes acting in and between the components of geosphere, hydrosphere, atmosphere and biosphere. Equally important is knowledge of how to manage and sustainably use the Earth's resources and understand the influence of human activity on the terrestrial system. It takes into account society's rapidly growing demand for well-trained Earth Scientists prepared to tackle scientific and societal issues.

The *bachelor's programme Earth Sciences* offers a broad and integrated spectrum of geological and geographical aspects, thereby considering the Earth as a dynamic system with particular emphasis on the interaction between physical and chemical processes at and below the Earth's surface and its evaluation through time. The committee applauds the breadth of the programme, offering students insight in many interrelating aspects of the Earth system.

The focus of the *master's programme Earth Sciences* is also broad. However, because students will have already obtained an undergraduate degree, it focuses on five research specialisations: *paleoclimatology and Geo-ecosystems (PG), Applied Environmental Geosciences (AEG), Earth Sciences and Economics (ES&E), Archaeometry and Landscape Archaeology (A&LA) and Solid Earth* (*SE)*. The committee values the broad spectrum of specialisations offered by the *master's programme Earth Sciences*, but is also concerned about its viability. Currently, the level is adequate, but the committee advises that its future viability should be carefully evaluated, because it takes much effort to maintain that many specialisations at the required level.

The *master's programme Hydrology* traditionally focuses on hydrological process studies, groundwater hydrology and hydrochemistry, remote sensing applications in hydrology, and (tropical) forest hydrology and the effects of change in land-use. The programme provides sound scientific knowledge and understanding of the functioning of natural and man-made ecosystems and the sustainable management of water resources over the full range of the

Earth's climates. It aims to educate students such that they achieve a sound understanding of the many different hydrological systems that exist under the wide range of geological and environmental conditions on Earth. The committee is aware that this programme is strongly focussed and well known internationally. It holds the opinion that the programme occupies a unique position in the domain specific framework of reference.

The primary aim of the *bachelor's programme* is to prepare students to become independent and critical academics who can play an active role in society. Besides this academic research orientation, the programme also aims to forge a clear link between Earth Sciences and society. The committee is positive about the orientation towards both a research and a professional career. Since the programme is currently taught in Dutch, the committee states that there is scope for improving its international perspective, in order to better prepare the students for the international market.

The aim of the *master's programme Earth Sciences* is to train students to operate as independent professionals within the disciplines covered by the master's programme, and to prepare students for a career in scientific research in the Earth Sciences or to apply Earth Sciences for consulting industries, governmental or other agencies. The committee concludes that the programme is strongly oriented towards academic research, but also demonstrates an adequate professional orientation.

The *master's programme Hydrology* is mainly academic research oriented, but it also aims to prepare graduates for a professional career. The committee holds the opinion that this balance in orientation is appropriate, considering that the programme is embedded in the Hydrology and Geo-environmental research groups.

The committee concludes that the *bachelor* and *master's programmes in Earth Sciences* properly relate to the domain-specific framework of reference. The framework is an effective and correct representation of Earth Sciences and offers enough anchor points for programmes to establish their own objectives. Derived from this framework of reference, the programmes have formulated intended learning outcomes. The intended learning outcomes are in line with the Dublin descriptors. The committee confirmed that the intended learning outcomes are in line within this framework and reflect the level, and orientation of both the bachelor and master programme. The committee applauds the profile, orientation and level of the *Hydrology master's programme*. The programme is strongly focussed on a unique subject. Their orientation, profile and subsequent learning outcomes are sound and reflect the intention to train students to become academic experts.

The Faculty *Aard en levenswetenschappen (FALW)* and *Exacte Wetenschappen (FEW)* of the VU plan to merge with their counterparts of the University of Amsterdam (UvA). In preparation for this merger, further cooperation between the Earth Sciences programmes at both universities will be explored, to develop and sustain an interdisciplinary educational programme.

Standard 2: Teaching-learning environment

Bachelor's programme
The bachelor consists of 180 EC divided over three years. The programme comprises basic, compulsory and optional courses, fieldwork and a thesis project. The programme is structured around the following specific themes; *Academic skills*, *Methods in Earth Sciences*, *Earth's building blocks*, *Dimensions in time and space* and *Social demands and impact*. The general

themes of the first year are further developed in the second year. In the spring of the second year, students have to select one of two more specialised study tracks: *Solid Earth* or *Earth Surface*. The tracks offer courses that provide more in-depth knowledge on the topics of the selected track, and prepare for the specialised, integrated field project at the end of the 2nd year. The third year of the programme starts with a minor, followed by 3 courses that are compulsory for both tracks. *Science History* and *Science Philosophy* are part of the theme *Academic skills*, while the courses *Applied Geophysics* and *Computer modelling* are part of the theme *Methods in Earth Science*. Finally, the programme is concluded with a BSc thesis project of 15 EC, in which the students take part in the research programmes of the Department of Earth Sciences.

The curriculum was recently revised (2011-2012). According to the programme managers, the changes primarily involved the introduction of the minor and the intention to increase the portability of the programme. Furthermore, the programme aims to strengthen the link between fieldwork and theory. The committee noted that the curriculum is organised in a structured way. It noted after comparison with the old curriculum, that the content of the new curriculum is more balanced.

The committee noted the relatively large amount of time devoted to fieldwork and the limited time available for auxiliary courses. As a consequence, the committee has noted that most students appear to feel less comfortable with quantitative and numerical methods and therefore choose more qualitative and descriptive research projects. The staff's assumption is that integration of theory and fieldwork will provide students with a better understanding of the system Earth. The committee does not disapprove of this didactic concept within the programme, but holds the opinion that its assumed advantage has to be proven before it can be justified.

Master's programme in Earth Sciences
The master's programme consists of 120 EC spread over two years. An overview is provided in appendix 4. The programme contains six research tracks *Paleoclimatology and Geo-Ecosystems (PG)*, *Applied Environmental Geosciences (AEG)*, *Earth Sciences and Economics (ES&E)*, *Archeometry (A)*, *Landscape Archaeology (LA)*, *Solid Earth (SE)*, and two communication tracks, *Education* and *Science Communication*. The tracks in Science Communication and Education are one-year programmes that cannot be combined with each other. They must be preceded by 33 EC of courses selected from one of the research specialisations. There are five research specialisations, which directly relate to the six research tracks (the Archaeometry and Landscape archaeology tracks are combined to provide a single specialisation *Archaeometry and archaeology*). The research tracks consist of compulsory and elective courses to equip students with the basic specialised knowledge and insights required by their specialised subjects. Courses are followed by a research project in the first year. When students choose a track in Science Communication or Education, the second year will focus on these aspects in relation to Earth Sciences and an internship. The internship leads to a final master thesis report, which can take the form of a policy document. Students, who follow a research track, undertake a research thesis project in their final year.

The committee concludes that the content and level of the *master's programme Earth Sciences* are sufficient to guarantee that students achieve the intended learning outcomes. It is convinced that together the tracks offer a broad spectrum of Earth Sciences and it approves of the offering of both a research and professional profile. Students feel well prepared for an academic research career. The main concern of the committee is the large number of specialisations. Although the strong connection with the research groups guarantees the

transfer of state of the art knowledge into the education programme, it may prove difficult to continue to offer all of these specialisations at the required level. Furthermore, the committee holds the opinion that freedom for students to choose courses within and among tracks reduces the coherence of the programmes followed by individual students and causes delays in study progress.

Master's programme Hydrology
The master's programme in Hydrology consists of 120 EC spread over two years. In the first phase, students gain basic knowledge, because there are no bachelor's programmes in Hydrology in the Netherlands. During this first phase of the programme, theoretical aspects of hydrology are combined with data-processing and analysis, computer modelling, literature study and presentation skills to address common questions in scientific hydrology, using hydrological data. General hydrological knowledge is supplemented by more specialised courses in ecohydrology and hydrogeology (9 EC). The latter courses focus on the hydrology of different geo-climatic settings, including differences in the functioning of contrasting ecosystems and land use types, and regional groundwater flow regimes and behaviour, respectively. After this stage of the programme in which students acquire their basic knowledge and skills, two fieldwork related courses are scheduled. In the second phase, more advanced and specialised courses are offered. The third phase is directed to specialisation and conducting a research project.

The committee concludes that the content and level of the *master's programme in Hydrology* guarantees that students fully achieve the intended learning outcomes. The content of the programme is well balanced and structured in such a way that all the relevant areas of knowledge and skills, related to Hydrology, are offered and appropriate training is provided. The curriculum is research oriented, but also prepares graduates for a professional career. The programme is very closely in line with the intentions of the programme, as formulated in the intended learning outcomes.

Didactic concepts and methods
All the VU programmes aim to offer an educational environment with ample scope for students to exploit their talents and achieve their ambitions. The committee values the creation of a context in which students are able to explore and express their own talent and ambition, but also noted that in this context students appear not to be intellectually challenged in an optimal manner. The committee advises that the aim to create an optimal context for realising the students' ambition on one hand, whilst expressing the programme's ambition on the other, should be actively maintained. It will enable students to improve themselves and become self-critical Earth Scientists.

Intake and studyload
The committee concludes that the intake numbers of the *master's programme* in *Hydrology* are of great concern. The committee recognises that the programme is unique, and therefore strongly supports the continuation of the current programme. It encourages the programme to develop several new initiatives to attract more students. For the *bachelor's and master's programme in Earth Sciences*, the intake numbers are increasing. Nevertheless, student progress is seen as an important source of concern. Many students do not graduate on time. The committee concludes that the programmes should devote more attention to student progress. The committee holds the opinion that a better expression of the programmes' ambition, accompanied by less possibilities for re-sitting assessments and less electivity in the master's programme will result in improved study progress.

Internationalisation
The committee suggests that the international orientation of both the *bachelor's and master's programmes in Earth Sciences* can be improved. There are many ways to increase their standing in the world, including attracting more students from abroad by gradually change the language of Dutch elements of the programmes into English. This will enhance the international orientation of the programme and help students prepare for the international market. The committee concludes that the *Hydrology master's programme* is already internationally orientated.

Staff
The committee concluded that the programmes are taught by lecturers who are both willing and able to pay close attention to the students. It is positive about both their research and educational qualities. Together with the bachelor- and master-coordinators and study advisor, they create a supportive and accessible surrounding for the students.

Quality Assurance
Recently, the bachelor's curriculum was revised. In the future, the increasing number of students in the bachelor and master in Earth Sciences will also influence the curriculum. Furthermore, there are uncertainties about the small number of students enrolling the Hydrology master's programme. The committee concludes that considering these circumstances, the programme needs to actively plan for the future. It holds the opinion that the Board of Education should take a more proactive and central role to guarantee the quality of the programmes. Furthermore, a positive and open attitude on the part of both management and lecturers is essential to make plans for maintaining the quality and quantity of staff.

Safety
Because it focuses on Earth Sciences, the programme includes fieldwork and practical training. Because safety is an important issue in fieldwork, the committee strongly recommends that a legally based safety assurance system is needed to legally protect faculty, staff and students. The committee applauds the already existing safety guidelines, but these documents have no legal status. As in other programmes in Earth Sciences in the Netherlands, lecturers, management and students are not fully aware of their responsibilities. The committee therefore recommends that a safety assurance system should be developed in cooperation with the other academic education programmes in Earth Sciences in the Netherlands. The current guidelines of the VU programmes in Earth Sciences will be very useful in implementing such a system, if they are given legal status. The committee also advises that teaching staff should ensure that safety rules are enforced in the field. Finally, the committee recommends obligatory first aid courses for both students and lecturers.

Standard 3: Assessment and achieved learning outcomes
The committee verified the assessment system and methods as well as the achievement of intended learning outcomes by students. It concludes that the assessment system is satisfactory.

The committee applauds the efforts of the assessment committee to evaluate the quality of the assessments. The committee encourages further improvement of this quality evaluation, e.g. with the introduction of peer review to evaluate the requirements of assessments. Although the committee suggests some improvements in grading the thesis, it is very positive about the use of the checklist to help in grading a thesis in an objective and transparent manner.

To assess the achievement of the learning outcomes, the committee has studied several theses. Based on the theses and the information gathered about progress and success rates, the committee has established that bachelor and master students achieve the learning outcomes to a satisfactory level. Most of the theses seen from the programmes in Earth Sciences have a qualitative research character. This is seen to result from a curriculum with a substantial part devoted to fieldwork and limited time allocated for training in methods of data analysis. The committee was nevertheless pleasantly surprised by some theses in which high level quantitative methods were used.

The committee assesses the standards from the Assessment framework for limited programme assessments in the following way:

Bachelor's programme Earth Sciences:

Standard 1: Intended learning outcomes	good
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment and achieved learning outcomes	satisfactory
General conclusion	satisfactory

Master's programme Earth Sciences:

Standard 1: Intended learning outcomes	satisfactory
Standard 2: Teaching-learning environment	satisfactory
Standard 3: Assessment and achieved learning outcomes	satisfactory
General conclusion	satisfactory

Master's programme Hydrology:

Standard 1: Intended learning outcomes	good
Standard 2: Teaching-learning environment	good
Standard 3: Assessment and achieved learning outcomes	good
General conclusion	good

The chair and the secretary of the committee hereby declare that all members of the committee have studied this report and that they agree with the judgements laid down in the report. They confirm that the assessment has been conducted in accordance with the demands relating to independence.

Date: 6 February 2013

Prof. M.A. Herber
(chair)

Dr. Willemijn van Gastel
(secretary)

Description of the standards from the Assessment framework for limited programme assessments

Standard 1: Intended learning outcomes

The intended learning outcomes of the programme have been concretised with regard to content, level and orientation; they meet international requirements.

Explanation:
As for level and orientation (bachelor's or master's; professional or academic), the intended learning outcomes fit into the Dutch qualifications framework. In addition, they tie in with the international perspective of the requirements currently set by the professional field and the discipline with regard to the contents of the programme.

Findings

The committee has evaluated the intended learning outcomes of the bachelor in Earth Sciences and the masters in Earth Sciences and Hydrology of the Vrije Universiteit Amsterdam (VU) with regard to content, level and orientation. It studied the domain-specific framework (1.1), the profile and orientation (1.2), the objectives and intended learning outcomes (1.3).

1.1 Domain-specific framework of reference

The domain-specific framework was created by the Chamber of Earth Sciences and educational administrators and/or heads of departments of the Dutch university institutions with degree programmes in the Earth Sciences (included in appendix 2). This framework is a modified version of the one established in 2006. In updating the framework, use was made of 'Agenda 2020: perspectives of the Earth Sciences', the outcome of a series of consultation workshops organised in 2009 by the Council for Earth and Life Sciences (RAL) of the Royal Netherlands Academy of Arts and Sciences (KNAW).

According to the domain-specific framework, Earth Sciences have the planet Earth as their object of study, its genesis and its quality of life. These sciences are strongly interdisciplinary, with interaction between various factors, such as humans, fauna, relief, soil, water, lithology, atmosphere, hydrosphere and vegetation. Knowledge is gathered about its origin, current and former composition, and structure and the processes acting in and between the components of geosphere, hydrosphere, atmosphere and biosphere. Equally important is knowledge of how to manage and sustainably use the Earth's resources and understand the influence of human activity on the terrestrial system. It takes into account society's rapidly growing demand for well-trained Earth Scientists prepared to tackle scientific and societal issues.

The committee studied the domain-specific reference framework and concludes that it is a well structured outline of the domain of Earth Sciences. Because the Dutch university institutions with degree programmes in Earth Sciences were involved in its creation, it is not surprising that such programmes fit readily into that framework, including the Earth Sciences and Hydrology programmes at VU. Although the framework is of Dutch design, the strong international research positions of the institutes guarantee its international relevance.

1.2 Profile and orientation

One of the recommendations of Agenda 2020 was to produce complementary Earth Sciences programmes in the Netherlands that together cover the entire domain. As a result, universities and their programmes will differ in their focus.

According to the critical reflection, the *bachelor's* programme focuses on a broad and integrated spectrum of geological and geographical aspects, thereby considering the Earth as a dynamic system with particular emphasis on the interaction between physical and chemical processes at and below the Earth's surface and its evolution through time. The programme is directed to the following domains of the domain-specific framework of reference: Geosphere, Surface and Biosphere-hydrosphere-atmosphere. The programme is unique in the sense of offering a small scaled programme with a strong integration of theory and practice.

The primary aim of the *bachelor's programme* is to prepare students to become independent and critical academics, who can play an active role in society. Beside this academic research orientation, the programme also aims to make a clear link between Earth Sciences and society. The committee sees the combined research and professional orientation of the programme as strength. The majority of the programme is taught in Dutch. The committee recommends to gradually change the language of those Dutch elements into English. This will enhance the international orientation of the programme and help students prepare for the international market.

The focus of the *master's programme in Earth Sciences* is also broad. However, because students will have already obtained an undergraduate degree, it focuses on five research specialisations: *pelaeoclimatology and Geo-ecosystems (PG), Applied Environmental Geosciences (AEG), Earth Sciences and Economics (ES&E), Archaeometry and Landscape Archaeology (A&LA) and Solid Earth* (*SE).* Furthermore, in addition to specialisation in one of these research areas, students are offered training in Science Communication and Education. The aim of the programme is to train students to operate as an independent professional within the disciplines covered by the master's programme. They are prepared for a career in scientific research in the Earth Sciences or in applied Earth Sciences, as in natural resources and consulting agencies, consulting industries, as well as in government. The committee notes the intention of the master's programme to offer a broad programme and to prepare students for both an academic research and professional orientation. However, it wonders whether this will continue to be viable. The offering of so many specialisations in addition to a broad orientation is highly demanding on both staff and students. Furthermore, some specialisations, such as Archaeology, require very specialised and current experience, and there may be problems in delivering such state of the art courses.

The *master's programme in Hydrology* traditionally focuses on hydrological process studies, groundwater hydrology and hydrochemistry, remote sensing applications in hydrology, and (tropical) forest hydrology and the effects of changing land-use. The programme provides sound scientific knowledge and understanding of the functioning of natural and man-made ecosystems and the sustainable management of water resources over the full range of the Earth's climates. It is strongly related to the Surface and Biosphere-Hydrosphere-Atmosphere subdomains of the domain-specific framework of reference. The committee finds that this programme is strongly focussed and well known both within and outside the Netherlands. It agrees with the management that this programme has a unique position in the domain-specific framework of reference. The programme is mainly research oriented but it also aims to prepare graduates for a professional career. The committee holds the opinion that this balance of orientation is appropriate, considering that the programme is embedded in the Hydrology and Geo-environmental research groups.

1.3 Objectives and intended learning outcomes

According to the critical reflection, the *bachelor's programme* aims to educate students to become academic geoscientists with scientific skills and a deep knowledge of the Earth. This general

aim, together with the intention to provide a high-standard academic education, is reflected in the formulation of intended learning outcomes according to the Dublin descriptors. The intended learning outcomes are subdivided into *Academic skills*, *Methods in Earth Sciences*, *Earth's building blocks*, *Dimensions in time and space* and *Societal demands and impacts*. The committee studied these learning outcomes and confirmed that they reflect the profile of the programme. The academic skills link to the research orientation whereas the societal demands and impacts are primarily important for the professional orientation. The committee concludes that the intended learning outcomes provide the right basis for offering both a research and professional orientation. The comparison with the Dublin descriptors shows that the learning outcomes are formulated at the bachelor's level.

The committee states that it is important for Earth Scientists to be able to communicate, whilst being aware of cultural and societal sensitivities. In line with this expectation, the committee studied the learning outcomes with respect to communication and ethical aspects. The committee concludes that the intended learning outcomes direct adequate attention to these aspects, although this could be further improved by closer integration with international aspects.

According to the critical reflection, the *master's programme in Earth Sciences* aims to provide students with the knowledge, attitudes, skills and insights that make a master's graduate capable of practicing his or her profession independently or qualified for further training in scientific research. This general aim, together with the intention to provide high-standard academic education, is reflected in the formulation of intended learning outcomes according to the Dublin descriptors. The committee studied these learning outcomes and confirmed that they reflect the profile of the programme. The learning outcomes fit both the research and professional orientation. The committee holds the opinion that the level of the programme is satisfactory. Nevertheless, the committee thinks that it may prove difficult to maintain this level for every specialisation.

The *master's programme in Hydrology* aims to educate students such that they possess a sound understanding of the many different hydrological systems that exist under the wide range of geological and environmental conditions on Earth. This requires an international focus and therefore training both within and outside the specific geological and environmental conditions encountered in the Netherlands. This general aim, together with the intention to provide high-standard academic education, is reflected in the formulation of intended learning outcomes according to the Dublin descriptors. The committee studied these learning outcomes and confirmed that they closely reflect the profile and orientation of the programme.

The department of Earth Sciences plans to merge with its earth science colleagues at University of Amsterdam (UvA). In preparation for this merger, further cooperation between the Earth Sciences programmes at both universities will be explored to develop and sustain an interdisciplinary educational programme. The challenge, but also the unique opportunity, will be to actually join forces and to plan for a well designed joint programme.

Considerations
The committee has studied the domain-specific framework of reference and the profile and orientation of the programmes. The objectives derived from this profile and orientation are reflected in the formulation of intended learning outcomes. The committee has evaluated the extent to which these outcomes meet the international requirements with respect to content, level and orientation. The committee concludes that the intended leaning outcomes of the

bachelor's and *master's programme in Earth Sciences* satisfy these requirements, whereas the *master's* programme *in Hydrology* meets the requirements well.

The domain-specific reference framework was developed by Dutch universities. The committee concludes that the framework offers a clear outline of the domain of Earth Sciences. The bachelor's and master's programmes at the VU fit within the domain, and they position themselves clearly.

The *bachelor's* programme aims to prepare graduates for enrolment in a master's programme in Earth Sciences but it also provides a professional orientation. The committee applauds for the breadth of the programme, offering students insight in the whole domain of Earth Sciences. The committee is also very positive about the orientation towards both a research and a professional career. Whereas the programme is currently mainly taught in Dutch, the committee finds that the programme could be enhanced in terms of preparing students for the international market by changing the language to English in due course. The level of the intended learning outcomes is reflected by the Dublin descriptors. Therefore, the committee concludes that the profile, level and orientation of the bachelor's programme are good.

The committee values the broad spectrum of specialisations offered by the *master's programme in Earth Sciences,* but it is also concerned about its longer-term viability. Currently, the level is adequate, but the committee advises that its future viability should be evaluated. The content of the learning outcomes is strongly related to academic research but also reflects an adequate professional orientation.

The committee applauds the profile, orientation and level of the *master's programme in Hydrology*. The programme is strongly focussed on a unique subject. Its orientation, profile and subsequent learning outcomes are sound and reflect the intention to train students to become academic research experts.

Conclusion
Bachelor's programme in Earth Sciences: the committee assesses Standard 1 as **good**.
Master's programme in Earth Sciences: the committee assesses Standard 1 as **satisfactory**.
Master's programme in Hydrology: the committee assesses Standard 1 as **good**.

Standard 2: Teaching-learning environment

The curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes.

Explanation:
The contents and structure of the curriculum enable the students admitted to achieve the intended learning outcomes. The quality of the staff and of the programme-specific services and facilities is essential to that end. Curriculum, staff, services and facilities constitute a coherent teaching-learning environment for the students.

Findings
In this standard, the findings of the committee regarding the extent to which the bachelor and master curricula enable students to achieve the intended learning outcomes are described. The findings are directed to the curriculum (2.1), didactic concept (2.2), quality assurance system (2.3), staff (2.4), intake and study load (2.5), facilities (2.6), support (2.7), internationalisation (2.8), and safety (2.9).

2.1 Curricula

The committee evaluated the *bachelor's* and the two *master's* programmes with regard to the intended learning outcomes. It studied the relevant tables included in the critical reflection, in which the courses are related to the intended learning outcomes and the Dublin descriptors. During the site visit, the committee discussed the curricula with programme managers, lecturers, students and alumni and studied the course material, assessments and course evaluations. The committee established that the content, level and orientation of the bachelor's and the two master's curricula are adequate and in line with the intended learning outcomes.

Bachelor's programme

The bachelor consists of 180 EC spread over three years. An overview is given in appendix 4. The academic year starts in September and consists of 60 EC each year, proportionally spread over six teaching periods. The programme consists of basic, compulsory courses, specialized courses, optional courses, fieldwork and a thesis project. The programme is structured around the following specific themes; *Academic skills*, *Methods in Earth Sciences*, *Earth's building blocks*, *Dimensions in time and space* and *Social demands and impact*. The curriculum was recently revised (2011-2012). According to the programme managers, changes were made due to the introduction of the minor and the intention to increase the portability of the programme. Furthermore, the programme aims to strengthen the link between fieldwork and theory. The committee noted that the curriculum is organised in a structured way and that the composition of the new curriculum is more balanced than before.

According to the critical reflection, the first year starts with courses linked to the theme *Earth's building blocks*, setting the scene of the programme. The intensive course *System Earth* provides the overview of the Earth System and all its subdomains. Programmed in parallel is the course *Rocks and Minerals* that includes the first field project in the Ardennes, Belgium, introducing methods used in Earth Sciences in the field. The field project is combined with a course on *General Academic Skills*, teaching students to set up a testable hypothesis, to collect field data, and to report the results. So within the first three months of the programme, students have already become familiar with the 'scientific cycle'. This is followed by courses that provide basic skills, such as *Mathematics and Computing*, and *Geochemistry & Physics*. Subsequently, the development of the Earth and the evolution of life are covered by courses in *Global Change* and *Sedimentology and Stratigraphy*. These courses are part of the theme *Dimensions*, with a focus on temporal dimensions, and provide preparation for the fieldwork. Finally, in the courses *Tectonics, Geomorphology* and *Map Constructions*, additional emphasis is given to spatial dimensions. These courses prepare the students for the final field project of the first year in Southeast Spain. In this practical project, the theory taught in the first year is fully integrated. In an individual assignment, students study the geology and geomorphology (and their interrelation) of a selected area, constructing stratigraphic columns, profiles and geological and geomorphological maps.

The general themes of the first year are further developed in the second year programme. Courses on methods in Earth Science in the 2nd year include *Mathematics & Physics, Statistics*, *Inorganic Geochemistry* and *Digital spatial data*. The theme Earth's building blocks are represented by the courses *Mineralogy*, *Sedimentary Systems*, *Introduction to Hydrology* and *Palaeoclimatology* and *Meteorology*. *Dimensions in time and space* receive special attention in the courses *Structural Geology*, *Quaternary Geology* and *Digital spatial data*. The course *Study and Career* informs the students about career possibilities and prepares them for the decision on the next step in their career, after completion of the BSc programme. An important part of this course is formed by presentations by alumni with a variety of careers, such as in industry, governmental

institutions or academia. In the spring, students must select one of two more specialised study tracks: *Solid Earth* or *Earth Surface*. The rest of the 2nd year programme consists of courses that provide more in-depth knowledge on the topics of the selected track, preparing for the specialised, integrated field project at the end of the 2nd year and for the specialised minor in the 3rd year.

The third year of the programme starts with a minor. The minor can be used to broaden the student's perspectives and opportunities, as it provides the opportunity to study a topic that is completely different from the major of choice. It can also be used as extra preparation for the master's programme. The programme itself offers a minor in either Solid Earth or Earth Surface. These minors consist of 5 courses of 6 EC each, making the total study load of the minors 30 EC. These courses will be taught in English to improve the English language skills of students and to prepare them for an international master and career, and also to attract foreign students for exchange programmes and pre-master programmes. The minors are followed by 3 courses that are compulsory for both tracks. *Science History* and *Science Philosophy* are part of the theme *Academic skills*, while the courses *Applied Geophysics* and *Computer modelling* are part of the theme *Methods in Earth Science*. Finally, the programme is concluded with a BSc thesis project of 15 EC, in which the students undertake projects related to the research programmes of the Department of Earth Sciences of VU Amsterdam.

The committee noted that a substantial part of the curriculum consists of fieldwork. The interviewed programme managers stated that fieldwork offers the opportunity to integrate theory and practice and thereby provide a better understanding of the whole Earth System. The committee understands this didactic concept but feels that the programme itself needs to evaluate the extent to which their students gain a better understanding of the Earth system by offering a curriculum with such a substantial part of fieldwork. Such an evaluation is needed to justify this didactic approach, because the large amount of fieldwork takes time away from teaching basic auxiliary knowledge and techniques. More specifically, the committee observed that maths and physics, together with quantitative analytical techniques, do not figure prominently in the curriculum. The interviewed lecturers did not entirely agree with this observation, because mathematics and quantitative analytical techniques are integrated into some courses. The committee encourages the programme to make informed choices and to accept that such choices will inevitably mean that some aspects will be less prominent.

According to the critical reflection, the course *mathematics and physics* is a course that students find difficult. The committee learned from students that they tend to postpone this course. They do not like the topic that much, although they stated that once started, the requirements of the course are feasible. The interviewed lecturer for this course explained that many efforts had already been made to make the course more attractive for the students. Specifically, course content was changed, embedding the formulae and theory into relevant practical examples, and students must now take mid-term assessments, which helps in motivating them to keep on track. The committee studied the course and concluded that the content of the course is very good. The course is well balanced at the bachelor's level and provides enough exercises and examples in which formula are embedded into practice. The committee feels that greater effort should be directed to ensuring that students complete this course on time. Tighter disciplines such as restrictions in re-sit opportunities are recommended.

During the site visit, the committee discussed the extent to which ethics and communication are covered by the curriculum. The curriculum does not direct explicit attention to these topics. The interviewed lecturers and programme managers agreed that the curriculum should pay more explicit attention to these topics. Nevertheless, they stated that most of the lecturers

integrate these topics into their courses. Furthermore, they argued that fieldwork provides a valuable opportunity for students to gain experience of communication with society in a real world context.

Bachelor thesis
The thesis process involves designing a research proposal, conducting research and reporting the results at the bachelor's level (15 EC). The thesis is conducted in one of the research departments of the programme and may involve a literature study or a study based on data generated from the field, laboratory or modelling. The committee noted that many theses reflect qualitative research. Although the committee is of the opinion that students in Earth Sciences should preferably be trained in using their tool kit of methods and techniques of quantitative analysis, it accepts the qualitative character of the theses. However, the committee also noted that some theses demonstrate a high level of mathematical expertise. The interviewed lecturers and students indicated that the programme offers opportunities for students to graduate without requiring extensive mathematical knowledge and insight. For those students, qualitative research topics are more appropriate. Students, with a strong interest in mathematics, have the opportunity to be challenged by highly quantitative research projects.

Bachelor fieldwork
A substantial part of the curriculum is fieldwork. In the first year, practical field project are scheduled in Brabant, the Ardennes and in the Southeast of Spain. During these projects, students independently perform a case study on landscape development in the area, with a focus on Quaternary stratigraphy and sedimentary environments. This project is concluded with a report. In the second year, the field project is located either in Spain (track Solid Earth) or in France (track Earth Surface), with a focus on practical field research skills for the individual student. These projects are concluded by preparation of a report, including a section on literature review. As stated above, the committee recommends that the benefits of including a large fieldwork component in the programme should be critically assessed.

Bachelor curriculum related to the learning outcomes
The critical reflection contains a table that summarises the contribution of courses and thesis to the achievement of the intended learning outcomes. The committee studied this table and concludes that the current relation between the curriculum and learning outcomes is adequate but could be improved by promoting the strengths of the curriculum more. For example, the learning outcomes are not directed to the programme's vision to focus on the integration between theory and practice. The committee recommends a bottom up approach to reformulating the intended learning outcomes, based on the intended characteristics of the curriculum.

Master's programme in Earth Sciences
The master's programme consists of 120 EC spread over two years. An overview is provided in appendix 4. The programme contains six research tracks *Paleoclimatology and Geo-Ecosystems (PG)*, *Applied Environmental Geosciences (AEG)*, *Earth Sciences and Economics (ES&E)*, *Archeometry (A)*, *Landscape Archaeology (LA)*, *Solid Earth (SE)*, and two communication tracks, *Education* and *Science Communication*. The tracks in Science Communication and Education are one-year programmes that cannot be combined with each other. They must be preceded by 33 EC of courses selected from one of the research specialisations, and a research project of 27 EC. There are five research specialisations, which match the six research tracks (the *Archaeometry* and *Landscape archaeology* tracks are combined in the *Archaeometry and archaeology specialisation*).

In this first year of the two-year programme, the students equip themselves with the basic specialised knowledge and insights for their specialised subjects. For the tracks AEG, A&LA and SE the first year curriculum contains 30 EC compulsory courses. ES&E contains 42 EC compulsory courses, and PG 45 EC compulsory courses. The students can either deepen their knowledge or choose to broaden their knowledge with about 15 EC optional courses. In the case of AEG, A&LA and SE this component precedes the research project. Those students following the PG, AEG, A&LA and SE tracks prepare for the research project, which accounts for about 15 EC of the curriculum, in the first year and this can be completed in the first semester of the second year. When students choose a track in Science Communication or Education, the second year will focus on these aspects of the Earth Sciences and an internship. The internship leads to a final Master thesis report, which can take the form of a policy document.

The committee confirmed that the research specialisations provide students with a thorough understanding of a particular part of Earth Sciences. The committee has noted that because of the strong connection with the research groups, state of the art knowledge is transferred directly into the education programme. However, as mentioned in standard 1, there is a need to consider the viability of so many tracks. It requires considerable effort to maintain all these research specialisations at the required level.

The committee was mainly concerned about the coherence of the individual programmes. The existence of elective options within a track and some overlap between them may cause students problems when deciding on a coherent individual programme. The interviewed students indicated that they value the ability to choose courses and to meander between tracks to some extent. The individual programme is finally approved by the Examination board. During their studies, students may receive advice from the study advisor or programme coordinator. The committee feels that the programme could to be more proactive in helping students to construct their individual programmes. It also advises that electivity within and between tracks should be reduced.

The committee discussed the extent to which ethics and communication are covered in the curriculum as it does not explicitly pay attention to these topics. As with the bachelor curriculum, lecturers and programme managers agreed that the curriculum should pay more attention to these areas, although many lecturers stated that they integrate these topics in their courses. Furthermore, fieldwork provides a lot of opportunities to train students to communicate with society within de context of their field activities.

Thesis
A first research project is started during the first year (27 EC) and a second research project or internship is conducted during the second year (24 to 39 EC). The research projects may contain fieldwork, laboratory work or modelling.

In the first year, students following the PG, AEG, A&LA and SE tracks prepare for the research project, which makes up about 15 EC of the curriculum in the first year and this is completed during the first semester of the second year. Within this project, the student translates theory-driven ideas into a research design. The research projects are associated with the research programmes of the scientific departments of the faculty, or are carried out in collaboration with a Dutch or international company or university. During the projects, students are taught to apply practical skills and to integrate their theoretical knowledge, in order to construct hypotheses. The work that is carried out is intended to contribute directly to the supervisor's research programme.

Students may opt to deepen their knowledge within a particular research field by selecting a different topic related to their specialisation for their master thesis (24 to 39 EC). In this case, the student will finish the master's programme with a distinct research specialisation. On the other hand, students may decide to broaden their knowledge by opting for an internship within a company. In this case, the student will go through the same specialisation process, starting by taking courses that aim to increase the student's theoretical knowledge, and finishing with an internship.

During the site visit, the advantages and disadvantages of conducting two projects, which could consist of two research projects or a research project and an internship, was discussed extensively. The interviewed students had doubts about the feasibility of two projects. They stated that it is hard to arrange two projects in the proposed time frame. Much time is spent in looking for a subject and finding an institute where the project can be conducted. The committee understands the obstacles and is aware that completing two projects may induce delay. On the other hand, two projects have their advantages. Lessons learned from the first project can be used in the second one. The committee recommends for the programme to re-evaluate the need for multiple projects in the student's curriculum in satisfying degree objectives, considering the added workload for students and staff.

Master Earth Sciences curriculum related to the intended learning outcomes
The critical reflection contains a table that summarises the contribution of the curriculum to achievement of the intended learning outcomes. The committee studied the table and confirmed that, in general, the programme enables students to achieve the intended learning outcomes. The learning outcomes reflect the research orientation of the programme well and also direct adequate attention to the professional orientation. The interviewed students stated that the programme offers a good preparation for a PhD career. They confirmed this statement by indicating that they feel comfortable and self assured with research activities. The professional orientation is, according to the students, less well developed. Nevertheless the committee has noted that the programme offers enough opportunities, e.g. an internship for students, to prepare for a professionally oriented career. Apparently, students need more help to explore these opportunities. The committee suggests that this need should be addressed, to ensure that graduates also feel capable of following a professional career in industry or government. The inclusion of guest lecturers in the programme could contribute to this.

Hydrology Master's programme
The Hydrology master's programme consists of 120 EC spread over two years. An overview is provided in appendix 4. According to the critical reflection, the programme is divided in three phases. In the first phase, students are provided with a basic knowledge of the subject. This is needed because there are no bachelor's programmes in Hydrology in the Netherlands. In the second phase, more advanced and specialised courses are offered. The third phase is directed towards specialisation and a research project.

Students start with an introduction to the general field of hydrology through a number of principal courses that provide in-depth coverage of the fields of catchment hydrology, groundwater hydrology, unsaturated zone hydrology, and hydrochemistry (24 EC). These courses build on basic natural sciences, mathematics, physics and chemistry courses followed earlier at the BSc level. This general hydrological knowledge is supplemented by more specialised courses in ecohydrology and hydrogeology (9 EC). The latter courses focus on the hydrology of different geo-climatic settings, including differences in the functioning of contrasting ecosystems and land use types, and regional groundwater flow regimes and

behaviour, respectively. During this first phase of the programme theoretical aspects of hydrology are combined with data-processing and analysis, computer modelling, literature study and presentation skills to address common questions in scientific hydrology, using hydrological data. The students are also encouraged at this stage to include optional courses in their programme to help define their specific interest or to improve their knowledge and skills in readiness for the next phases of the programme (9 EC). Examples include learning how to work with geographic information systems to study spatial patterns, the use of remotely sensed information in hydrology, or the application of chemical and isotope tracers in hydro(geo)logy. After this stage of the programme, in which students gain their basic knowledge and skills, two fieldwork related courses are scheduled. After these courses, advanced courses on groundwater transport processes and hydrological modelling (12 EC) are offered, and these are followed by further specialisation of the student in his/her area of interest through optional courses (21 EC).

As for the master's and bachelor's programme, the committee finds the attention in the curriculum on ethics and communication weak. As with the bachelors programme, lecturers and programme managers agreed that the curriculum should direct more attention to these aspects, although they are already integrated in their courses by most lecturers. Furthermore, the fieldwork provides opportunities for training in communication with society in the proper context.

The committee studied the content and structure of the curriculum. It applauds the content and structure of the curriculum. The programme succeeds in offering a developmental curriculum, guiding students from basic knowledge and skills to their specialisation. The content of the courses is well conceived and contributes in an effective way to the overall curriculum. The committee has noted the strong connection with the research groups. As a consequence, state of the art knowledge is transferred directly into the teaching programme.

Fieldwork
There are two fieldwork related courses, the *Instrumentation Field Course* (Netherlands) and the *Field Course Hydrology* (Portugal) with a total of 18 EC. The fieldwork component is considered to be one of the most important elements of the student's hydrological education, because it is during these field courses that the student is challenged for the first time to solve real and complex hydrological questions in a real-world environment. The interviewed lecturers stated that the fieldwork component offers important opportunities to both research oriented students, as well those destined for a career in industry, engineering companies or government.

Thesis
The final research project results in an MSc thesis (27 EC). This project can be executed at the VU or at another (intern)national research organisation. One of the options is to extend the final research project with 12 EC from the optional courses.

Master in Hydrology curriculum related to the intended learning outcomes
The critical reflection contains a table that summarises the contribution of courses, internship and thesis to the achievement of the intended learning outcomes. The committee studied the table and confirmed that the programme is very well aligned with the intended learning outcomes. The programme succeeds in translating their intentions into a sound programme.

2.2 Didactic concept and methods

According to the critical reflection, the VU aims to offer an educational environment which provides ample scope for students to exploit their talents and fulfil their ambitions. During the visit, the committee has noted several examples expressing this concept in both the bachelor's and *masters' programmes*. For example, students are offered a lot of freedom in choosing their curriculum and they are allowed to resit examinations on several occasions without any penalty. The committee noted that the interviewed students greatly value this freedom. The committee recognises the importance of creating a context in which individual students are able to explore and express their own talents and ambitions, but also noted the potential disadvantages of such an environment. Considering the negative attitude of the students to the mathematics course that causes delay, it seems that students are not encouraged to come out of their comfort zone to meet the requirements of the programme. The committee sees a need to balance the aim to create an optimal context for realising the students' ambition and meeting programme requirements. This will encourage students to improve themselves and to become self-critical Earth Scientists.

Another aspect of the didactic concept is the importance of fieldwork. As indicated in the previous paragraphs, the committee is convinced of the essential role fieldwork plays in an earth science educational program. However the amount of time spent in the curriculum is considerable. The committee is willing to approve this concept as long as the programme is able to provide assurance that the integration of fieldwork into the curriculum contributes to a better understanding of the Earth system.

The methods used in the *bachelor's programme* are lectures, practicums and individual projects, including the internship and/or a research project. In the bachelor's programme, the contact hours for lectures and practicums (including field work), account for most of the programme. The teaching methods in the *master's programme in Earth Sciences* and the *Hydrology master's programme*, are essentially similar to those used in the bachelor's programme. Besides lectures, tutorials in small groups are offered. In the second year, a thesis and traineeship are scheduled. As a consequence, the teaching methods are mostly defined by self-study and individual support by lecturers.

2.3 Quality Assurance

The committee explored the extent to which students and lecturers are involved and heard in the evaluation and improvement of the quality of the *bachelor's* and *master's* programmes.

According to the critical reflection, the faculty has a policy of having all newly-developed courses evaluated by the students, whereas existing courses are evaluated on a tri-annual basis only. A summary of the evaluations is made available to the lecturers involved, who may use these to improve poorly evaluated aspects of the course. The director of studies and the Board of Education also review these evaluations and can require changes to be made to those parts of a course that have been evaluated as poor. In addition, just before graduation, students are asked to complete an evaluation of the entire programme. During the site visit, the committee learned from the Board of Education that the evaluation of individual courses is formalised, whereas the evaluation of the whole curriculum is less formal. The committee holds the opinion that the evaluation of the courses and programmes can be improved. Firstly, it recommends that the whole curriculum should be monitored on a regular basis. This will provide insights into the coherence of the programmes and the extent to which all the intended learning outcomes are met. This is a particularly important issue for the master's programme in Earth Sciences. Secondly, the committee states that evaluating on a tri-annual basis is inadequate. It is important to improve the programme as soon as deficiencies are

found. An evaluation once in three years does not offer that opportunity. Thirdly, the committee encourages the use of more sources to evaluate the curricula. Peer review is a frequently used and effective method for quality evaluation and improvement.

The committee discussed the role of the Board of Education. The Board recently split into a bachelor board and a master board. Sometimes they arrange meetings together on an ad hoc basis. The Board indicated that it formally advises the Faculty Board, and that informally it also advises the committee established to draw up the new curriculum. During the site visit, the committee noted that the Board is not well informed about the plans to merge with their counterparts at UvA. The committee thinks that it should be. The committee recommends that the Board should adopt a more proactive attitude, including constructive discussions with the programme management to realise the merger in such a way that the identity of the programmes will not be lost.

2.4 Staff

The committee evaluated the quality and quantity of the staff.

According to the critical reflection, the scientific quality of the staff is demonstrated by their active participation in research, and the fact that almost all tenured staff hold a PhD degree. The committee confirmed the evidence of high scientific quality of the lecturers and observed a strong integration of research and education.

Teaching for the bachelor's and master's programmes is provided by lecturers who dedicate on average 0,1 to 0,5 fte to teaching. In the bachelor programme, and the Hydrology master's programme, more than half of the staff (54-58%) hold a Basic Teaching Qualification (BKO). In the master's programme in Earth Sciences, the percentage is lower (30%). New staff are required to follow the courses needed to obtain a BKO. For existing personnel, the qualification is a mandatory prerequisite for promotion. The committee read student evaluations which expressed appreciation of the teaching skills of the lecturers. The committee recognises that it is difficult to force existing staff, who have been lecturing for many years, to obtain a BKO. It is, however, pleased to see that those staff are offered other kind of courses. It nevertheless encourages lecturers to seek out up to date information about new education methods and techniques. The university should be in a position to provide such information.

The committee noted a relatively low staff-student ratio of 1:20 in the *bachelor's programme*. In the *master's programme in Earth Sciences*, the ratio increased to 1:6 and in the *Hydrology master's programme* to 1:2,5 in 2005-2006 and to 1:5,6 in 2011-2012. The committee noted that a substantial proportion of the staff will retire in the near future. In light of the increasing number of students, the committee sought information regarding the policy for maintaining a sufficient number of high quality lecturers. The programme managers who were interviewed indicated that they did not foresee problems because the vacancies would be filled and departing staff would therefore be replaced. However, the lecturers who were interviewed expressed their concerns because they were not convinced that vacancies would be replaced. The committee advises that open communication between programme managers and lectures is required on this subject. It can foresee that in the future, some restructuring of the staff may be required. The committee strongly advises that lecturers and management work together to assess the best strategy for any such restructuring.

The interviewed lecturers perceive their workload as high. They indicated that a balance between teaching and research is sometimes difficult to maintain, due to the large amount of

time needed to prepare applications for research funding. They are also concerned about likely increases in the teaching workload in the future and uncertainties about the programmes related to the plans to merge with the UvA. For the Hydrology master's programme, there were also concerns regarding the future continuation of the programme, due to the relatively low number of students. The committee applauds the observed attitude of the lecturer's in not making their concerns evident to students. Lecturers are very accessible to students and seem not to draw attention to their perceived high workload. The committee holds the opinion that the lecturer's concerns must be addressed. Therefore, on the one hand, the committee advises the programme management to reduce the lecturer's anxiety by open vertical communication. Furthermore it advises the programme management to openly support their staff. For example, the mathematics course is very well structured, although the students think otherwise. The committee recommends that the management should openly approve this course and to make clear to students that its level will not be downgraded as they might wish. On the other hand, the committee encourages lecturers to reassure themselves and be prepared for the future. The future will bring some challenges but also many opportunities.

2.5 Intake and study load

Appendix 5 shows the figures for enrolment, efficiency and drop-out.

The required pre-university education for the *bachelor's programme* is education with a scientific character, including physics, chemistry, and mathematics. In September 2011, the binding study advice (BSA) is introduced. Students, who have not collected 36 EC out of 60 EC, are not allowed to return to the programme within three years.

Students applying for enrolment in the *master's programme* in *Earth sciences* present documentation about the preceding bachelor's programme or other academic training. Students who completed the bachelor's programme in Earth Sciences at VU have their study programmes checked and compared with the selection of course modules necessary for the tracks *Earth sciences and economics, Archeometry* and *Landscape archaeology*. At present, the majority of students applying for the master's programme hold a bachelor's degree from VU. Other graduates from national or international universities also apply for admission for the programme. In general, these students need to have completed a BSc education with a qualification higher than lower second-class honours and demonstrate a solid background in mathematics, physics, chemistry and earth sciences. International students also have to fulfil the English language requirements set by the VU. Students from Dutch institutes of higher education (HBO) are required to undergo a non-binding assessment at the VU to test their academic potential. Only students with limited deficiencies (less than 12-18 EC) are considered for conditional admission by the Examination board. The master programmes do not currently use the 'harde knip' but it will be introduced in September 2013. The Examination board may decide to allow students from the bachelor's programme in Earth Sciences at the VU to attend some courses and interim examinations of the master's programme before he or she has successfully completed a bachelor's degree, provided that the student has accumulated at least 168 out of a total of 180 ECTS within the Bsc programme.

Admission to the *master's programme* in *Hydrology* is granted automatically to students having a BSc degree in Earth Sciences from the VU or other universities in the Netherlands. Students with a foreign bachelor's degree in Earth Sciences are admitted if they passed a bachelor's programme with a qualification higher than lower second-class honours and have fulfilled the English language requirements set by the VU. Students from Dutch institutes of higher

education (HBO) are required to undergo a non-binding assessment at the VU to test their academic potential. Only students with limited deficiencies (less than 12-18 EC) are considered for conditional admission by the Examination board, upon advice from the Msc coordinator. Such students may be admitted to the programme by the Examination board upon condition that the deficiency is addressed within the first year of the master's programme.

Student enrolment in the *bachelor's programme* has increased from 35 in 2006-2007 to 65 in 2011-2012. Forecasts for intake in September 2012 indicate that the intake is still increasing. In the *master's programme in Earth Sciences*, the enrolment has increased from 12 in 2006-2007 to 29 in 2011. The student enrolment of the *master's programme in Hydrology* has increased from 5 in 2006-2007 to 15 in 2011. A programme is considered to be feasible if the number of students is 20 or higher. When the number is lower, actions have to be taken. In general, such small programmes will be integrated into a larger programme, unless there are convincing reasons to maintain the programme. Specifically to maintain a programme with less than 20 students, permission of the Faculty Board is required. The committee stressed the importance of the Hydrology master's programme, considering the importance to ensure complementarity of all Earth Sciences programmes in the Netherlands. This programme has a unique niche in Earth Sciences and should therefore be cherished. The committee advises the programme to cooperate with other programmes in Earth Sciences in the Netherlands to attract more students. It also stresses the importance of maintaining highly qualified staff.

The committee has noted that almost half of the students in both master's programmes are female. The committee is very positive about this ratio. It is also pleased to observe the expressed intention of female lecturers to attract more female students and lecturers

Appendix 5 shows that in the *bachelor's programme*, the dropout rate is less than 20% and around 43% graduate after four years. The committee noted that these rates are disappointing but is aware that it is partly due to the lack of a 'harde knip' and a binding study advice (BSA) prior to 2011. Students commence their master's programmes and therefore have no great incentive to finish their bachelor's programme. The committee also noted that the programme offers many re-sit opportunities. This is one example of the programme trying to be too helpful to students. The committee holds the opinion that besides helping students the programme has to be more demanding. In the *master's programme* in *Earth Sciences,* the drop-out rate is on average 16% and 43-60% of all students graduate in three years. In the *Hydrology master programme*, the drop-out rate is around 10% and on average of 70% of all students graduates in three years. Considering the progress of the students in the *Earth Sciences master's* programme, the committee holds the opinion that the programme is too wide ranging. A more clear and structured curriculum will keep students on track. Furthermore, as observed in the master's programmes, the (over)facilitating nature of the programmes is likely one of the reasons of delayed students graduation.

Study load
In the bachelor's programme, the study load is evenly distributed with 60 EC in each year, spread over six teaching periods. The Earth Sciences and Hydrology master's programmes are also offering curricula in which the workload is evenly distributed. During the site visit, students did not indicate that the programmes were too demanding.

2.6 Facilities
Based on written documentation and a guided tour, the committee is convinced that the facilities are adequate. Laboratories are very well equipped and serve their purpose. The

computer facilities are high tech and of high quality. Some students complained that insufficient examination rooms are available. For example, students with dyslexia need more time for their examinations. However, during exams, students can be interrupted and asked to move elsewhere, because the room is reserved for other purposes. The committee holds the opinion that greater flexibility in the examination time tabling system is needed to solve those problems.

2.7 Support

During the conversation with students, the committee noted that student support is satisfactory. They informed the committee that contact is possible when required. The committee learnt that the study advisor is responsible for approximately 900 students. Therefore, a proactive attitude cannot be expected. Nevertheless, the committee noted that students also receive support from the bachelor's and master's coordinators. Students are intensively monitored by the coordinator, who monitors the individual's progress and holds one-to-one meetings when necessary. In addition, the interviewed students indicated that the lecturers are very accessible and willing to help if required. There is close contact between lecturers and students. The interviewed international students indicated that information that they needed was easy to find. The student association GeoVUsie is also very active and invites students and lecturers for guest lectures or an informal drink on a regular basis.

The committee concludes that student support is well structured. Nevertheless, given the slow progress and the substantial percentage of drop outs, it seems that some students slip through the net of support. It therefore stated that the support system would be more effective if it was more proactive and such changes are recommended.

2.8 Internationalisation

The bachelor's programme is taught mainly in Dutch and almost no students go abroad to follow classes at foreign universities. To attract more international students, the minor in the new curriculum will be taught in English. The committee suggests that the programme could be organised more internationally. The aim of the programme is to prepare students for the global market. This aim can never be reached without an international character. The committee appreciates that internationalisation is on the management's agenda but encourages them to expedite their plans. For example, it is recommended to change the language of Dutch course elements into English at appropriate moments during lecture development.

The committee learnt that, at present, only three foreign students are registered for the *master's programme in Earth sciences*. In the *Hydrology master's programme*, half of the students are from abroad.

The committee suggests that the master's programme in Earth Sciences should be given a more international identity. For example, the programme could establish formal collaboration with one or more international educational institutes in Earth Sciences, which would facilitate the exchange of students. The committee was impressed by the international character of the Hydrology master's programme.

According to the VU policy, students applying from abroad have to pay an application fee for administration reasons. If they are admitted, this is refunded. This application fee and the study fees for students from outside the European Union, adversely affects the recruitment of overseas students. Especially for the Hydrology master's programme, this can be working out dramatically. The committee recognised that the need to pay an application fee up front could

have some advantages, since only highly motivated students would apply to enter a programme. Furthermore, it learned from the programme managers that other means of promoting international exchange are being explored, e.g. introducing an English taught minor in the bachelor's programme and exploring different sources for scholarships in the Hydrology master's programme.

2.9 Safety

An important issue related to fieldwork is safety. In order to guarantee that students are aware of the risks, dangerous situations and safety rules, they have to sign a form before each fieldtrip. During the site visit, the committee discussed this topic with management, lecturers and students. The committee studied the documents' regulations for safety in the fieldwork' and the report 'guidelines for safety in fieldwork'. The committee was very impressed by the comprehensive nature of these reports. They offer a good framework for informing students and lecturers about the do's and the don'ts of fieldwork. Unfortunately, however, the documents have no legal status.

Fieldwork has its risks, accidents may occur, and the consequences can be immense. Therefore, it is necessary to carry out fieldwork with a legally based safety assurance system. The committee recommends that these reports should be revised to give them a legal basis. The committee would be pleased if the resulting documents could be shared with the other earth science programmes at universities in the Netherlands. The committee also advises that teaching staff should ensure that safety rules are enforced in the field. Finally, the committee recommends that obligatory first aid courses should be provided for both students and lecturers.

Considerations

The committee concludes that the content and level of the *bachelor's programme* are adequate to guarantee that students achieve the intended learning outcomes. The curriculum is well structured and provides a solid basis for subsequent enrolment in a master's programme in Earth Sciences. The committee applauds the fact that the programme realises the intention to cover the whole domain of Earth Sciences. It is also positive towards the intention to offer both a research and a professional orientation.

The committee noted the relatively large amount of fieldwork, which results in limited time for auxiliary courses. As a consequence, the committee has noted that most students feel less comfortable with quantitative techniques and therefore tend to favour qualitative and descriptive approaches for their projects. The committee is willing to accept this didactic concept of the programme, but holds the opinion that the assumed advantage of providing a better understanding of the system Earth has to be proven before it can be used as a justification.

The committee concludes that the content and level of the *master's programme in Earth Sciences* are adequate to guarantee that students achieve the intended learning outcomes. The committee is convinced that all the tracks together offer a broad spectrum of Earth Sciences. The committee approves offering both a research and professional profile. It is a compliment for the programme that students are well prepared for a professional career. The main concern of the committee is the amount of specialisations. Although the strong connection with the research groups guarantees the transfer of state of the art knowledge into the teaching programme, it may prove too demanding to keep offering all the specialisations at the required level. Furthermore, the committee holds the opinion that the freedom given to students to choose courses within and among tracks reduces the coherence of the

programmes followed by individual students and is the likely cause of delays in study progress.

The committee concludes that the content and level of the *Hydrology master's programme* guarantees that students readily achieve the intended learning outcomes. The content of the programme is very relevant and every course makes a substantial contribution to the overall curriculum. The curriculum is primarily directed to delivering academic researchers. However, the curriculum also prepares graduates for a professional career. The curriculum is well aligned with the aims of the programme, as formulated in the intended learning outcomes.

The committee holds the opinion that the didactic concept, which aims to create a learning environment in which students are able to explore and express their own talents and ambitions, is a noble vision. As a positive consequence, students are given a lot of freedom in their studies and can seek guidance from lecturers, coordinators and the study advisor in navigating their way through the many choices available. However, on a more negative note, the committee has seen signals indicating that students are not always capable of taking responsibility for their individual programmes. Examples are the relatively strong delays in graduation and the tendency to avoid demanding courses as Mathematics. The committee holds the opinion that the programme has to take the lead in developing and safeguarding their own ambition for the programme and that it does not always give in to student demands when it comes to course rigor and program requirements.

The committee concludes that the quality assurance of the programmes can be improved. The curriculum was recently revised and in the future, the merger plans and an increasing number of students in the bachelor programme may influence the curriculum as well. Under these circumstances, a proactive Board of Education is necessary.

The committee concluded that the programmes are provided by lecturers who are capable of and willing to pay close attention to the students. It is positive about the research and education qualities of them. The committee learned that uncertainties about merger plans, student numbers and the replacement of retiring lecturers exist and may influence the motivation of the lecturers. The committee holds the opinion that a positive and open attitude on the part of both management and lecturers is needed to maintain the quality and quantity of staff.

The committee concludes that the relatively low intake numbers for the *Hydrology master's programme* is of great concern. The committee holds the opinion that the programme is unique in the Netherlands, and strongly recommends management to support and maintain the programme. It encourages the introduction of several activities to attract more students. For the bachelor's and master's programme in Earth Sciences, the intake numbers are increasing. Nevertheless, there are concerns regarding the progress of the students. Many students do not graduate on time. The committee concludes that the programme should give increased attention to the progress of the students.

The committee concludes that the international character of both the *bachelor's and master's programme in Earth Sciences* is not well developed. There are many ways to increase their standing in the world, including attracting more students from abroad and by providing exchange opportunities for their own students. The committee concludes that the *Hydrology master's programme* has a well developed international perspective.

The committee applauds the current safety assurance system. It would be perfect if the system is given a legal basis, if the guidelines are rigorously enforced and obligatory first aid courses are provided.

Conclusion
Bachelor's programme Earth Sciences: the committee assesses Standard 2 as **satisfactory**.
Master's programme Earth Sciences: the committee assesses Standard 2 as **satisfactory**.
Master's programme Hydrology: the committee assesses Standard 2 as **good**.

Standard 3: Assessment and achieved learning outcomes

The programme has an adequate assessment system in place and demonstrates that the intended learning outcomes are achieved.

Explanation:
The level achieved is demonstrated by interim and final tests, final projects and the performance of graduates in actual practice or in post-graduate programmes. The tests and assessments are valid, reliable and transparent to the students.

Findings

3.1. Assessment system and methods

The committee studied the examination policy, the role of the Examining Board and the quality of several assignments. Special attention was paid to the procedure to assess the students' performance during the thesis project.

The committee learned that the Examination board is responsible for the entrance qualification requirements and intended learning outcomes of the entire bachelor's and master's programmes in Earth sciences, including the Hydrology master's programme. It is responsible for the overall academic level of the bachelor's and master's programmes and its components. Furthermore, the board must approve the individual curricula of students. It is not involved, however, in setting the course criteria for grading. The board reports to the Faculty board. Recently, some members of the examination board also became members of the assessment committee (Toetscommissie). The committee read the minutes of the assessment committee and applauds its efforts. It evaluates assessments and thesis reports in terms of feasibility and completeness, and analyses students' evaluations in an effective way with a view to implementing improvements where required.

The programmes use several methods of assessment, including written exams, reports and oral presentation. The committee concludes that the variety of assessment methods is appropriate. It fits within the aim and structure of the programme. As already stated, there are probably too many opportunities for re-sits. Restricting the opportunities for re-sits will help students to keep on track. The committee is pleased to see the introduction of mid-term assessments. Students are forced to start studying efficiently, leading to better results. From the committee's perspective, the success rate can be further improved by providing more formal feedback. Students get feedback on oral presentations but not for written exams or reports. The interviewed students agreed that feedback is often lacking, though they can always ask for it.

The committee learned that lecturers are setting and grading assessments on a personal basis. In this process, they are guided by filling in a checklist. The checklist is directed to the process of setting assessments according to the aims of the course. The committee approves this procedure because it guarantees transparency and accuracy to some extent. However, from the perspective of the committee, objectivity and accuracy can be further improved by using peer reviews of the actual exam questions to thoroughly evaluate the nature and content of the assessments. Also the creation of some general rules will help to create an effective assessment system.

For the *bachelor's* and *master's* thesis projects, students are required to write a research proposal, including a description of the problem, the objectives, the research questions and the methodology for data collection. According to the critical reflection, the theses are assessed on the following aspects; 1) attitude; 2) methods; 3) content of the report; 4) layout and 5) oral presentation. The aspects attitude, methodology and progress are also assessed during a mid-term review. A checklist helps in formulating an evaluation of each aspect by listing points to consider. For example, points to be considered for the aspect *attitude* are *motivation*, *independence*, *insight*, *accuracy*, *initiative*, *creativity* and *cooperation*. Every point can be graded on a four point scale. Lecturers decide in advance the weighting of each aspect in producing the final grade. These grades, together with interim assessment notes are added to the final form and communicated orally to the student.

A minimum of two persons are involved during the thesis project to guide and assess the student. The first examiner is a VU lecturer. This person is responsible for supervising the process and is present at the six-week evaluation and final presentation. He or she will provide remarks independently of the day to day supervisor.

The committee is very positive about the checklist. It provides a transparent and objective thesis assessment. Nevertheless, the committee sees opportunities to improve it. Firstly, the committee disapproves of the allowed variable weighting of the aspects attitude, results and oral presentation. From the committee's point of view, it is fairest to establish a standard grading system for all students, with no difference in the weighting of the criteria according to track or lecturer. The Examination board agreed and indicated their intention to fix the weightings in the future. Secondly, it advises that rubrics which clarify the boundary between pass and fail grade should be formulated. Thirdly, it recommends that narrative feedback should be provided either on the form or as addendum. Oral grading can be sufficient for some purposes, but for students it is important that they should be able to read and digest and re-read the comments.

3.2 Success rate and performance

Based on the theses and the careers of both bachelor and master graduates, the committee confirmed that the intended learning outcomes are achieved.

Bachelor's programme

Prior to the site visit, the committee received 15 bachelor theses selected from a list in the critical reflection of all the theses completed in the last two years. The theses were selected to cover the range of the research topics. Emphasis was placed on the theses graded with a six. The committee concludes that the quality of all these theses was sufficient. Some theses were of a very high quality and used highly demanding data analysis techniques. Most of them, however, were more descriptive in character. As already stated, the committee stated that descriptive research was acceptable, but that graduates in Earth Sciences should still be trained in using quantitative research methods. The committee noted that in the list of

bachelor graduates 2010/11, provided in the critical reflection (Appendix F), the EC's assigned to the thesis work varies considerably between 12 and 24, whereas the nominal number of EC's for a bachelor thesis is 15. The programme managers declared that in the past, 18 EC was nominal, with the possibility to extend to 24 EC or to diminish to 12 or 16 EC. As since last year, the number is fixed at 15 EC. The committee was pleased to hear that the number of EC is standardized.

According to the critical reflection, the majority of the bachelor graduates continue on to a master programme. The graduates who follow the Master Earth Sciences and Master Hydrology encounter no particular problems. This indicates that bachelor students achieve the intended learning outcomes and are well prepared for a master.

Master's programme Earth Sciences
The committee selected 15 master theses using the same procedure as described for the bachelor theses. The committee studied these theses and concluded that their quality conformed or exceeded their expectations. The theses show convincingly that students acquire the programme's intended learning outcomes. In common with the bachelor theses, the content of most of the theses was qualitative in character.

The committee noted that some theses represented the work of two persons. The lecturers explained that such joint work is permitted, but only under strict rules. For example, if two persons are involved in the same field work project. However, in that case, both students have their own research questions to answer and it is clear which part of the report was produced by whom. The committee advises the Examination board to enforce these rules more stringently, because it has read a report written by two persons and in which no indication of their individual input was provided.

The committee is aware that graduates readily take up PhD positions as well as positions in industry or government. This indicates that the master students achieve the intended learning outcomes and are well prepared for the next step in their career.

Master's programme in Hydrology
The committee selected six master theses in the same procedure as described for the bachelor theses. The committee studied these theses and concludes that their quality conformed to, or exceeded their expectations. The theses show convincingly that students acquire the programme's intended learning outcomes. The committee applauds the scientific level of the theses, considering that a bachelor programme Hydrology does not exist. Therefore, the master students start their studies without strong background knowledge.

The committee noted that there were no 6s. The grades were all in the range 7 to 8. The Education board indicated that it is to the programme's credit that students graduate with at least a 7. However, considering the fact that students start the programme without a strong background in hydrology, it is very hard to graduate with a 9. The committee also noted that some theses were written in Dutch. The interviewed lecturers explained that some governmental institutes, involved in the research, require reports written in Dutch. The committee understands this situation, but suggests that in such circumstances the thesis should be written in English and accompanied by a Dutch summary.

Considerations
The committee verified the assessment system and methods as well as the achievement of the intended learning outcomes by students. It concludes that the assessment system is satisfactory.

The committee applauds the efforts by the assessment committee, in assuring the quality of the assessments. The committee encourages the assessment committee to improve this quality assurance further, e.g. with the introduction of peer reviews to monitor the setting of assessments. Although the committee suggests that there is scope for some improvement in the procedure for grading theses, it is very positive about the use of the checklist to help grade a thesis in an objective and transparent manner.

To assess the achievement of the learning outcomes, the committee studied several theses. Based on the theses and the information gathered about progress and success rates, the committee confirmed that bachelor and master students achieve the learning outcomes to a satisfactory level. Most of the theses of the programmes in Earth Sciences have a qualitative research character. The committee concludes that this type of research is acceptable, but not outstanding. The committee is impressed by the quality of some theses in which students demonstrate a high level of skill in applying quantitative methodologies.

Conclusion
Bachelor's programme Earth Sciences: the committee assesses Standard 3 as **satisfactory**.
Master's programme Earth Sciences: the committee assesses Standard 3 as **satisfactory**.
Master's programme Hydrology: the committee assesses Standard 3 as **good**.

General conclusion

The *programmes in Earth Sciences* succeed in offering insight in the whole domain of Earth Sciences whereas the Hydrology master's programme focuses on a niche in this system that is unique for the Netherlands. The committee applauds the curriculum of the *Hydrology master's programme* that is very well aligned with its aims and intended learning outcomes.

The committee has identified four main issues needing special attention. The substantial amount of fieldwork in the *bachelor's programme* should be justified because it results in limited time for the teaching of quantitative analysis techniques. As a consequence the research experience of a lot of graduates is more qualitative than quantitative. Secondly, the *master's programme in Earth Sciences* offers a lot of tracks and electivity. Therefore, it is hard to guarantee coherent individual programmes. Furthermore, it may prove difficult to maintain all the specialities at the required high academic level. Thirdly, the programme has to deal with the changes and uncertainties concerning intake, retiring staff, staff replacement and the possible merging with their counterparts of UvA. Fourthly, the committee strongly recommends that a legally based safety assurance system should be developed as a matter of urgency, to legally protect faculty, staff and students. In this context, teaching staff should ensure that safety rules are enforced in the field. In addition, obligatory first aid courses should be provided for both students and lecturers.

The committee is convinced that the quality of the bachelor's and master's programme is maintained by highly motivated and capable lecturers and other persons who are responsible for the programmes.

Conclusion
The committee assesses the *bachelor's programme Earth Sciences* as **satisfactory**.
The committee assesses the *master's programme Earth Sciences* as **satisfactory**.
The committee assesses the *master's programme Hydrology* as **good**.

Appendices

Appendix 1: Curricula vitae of the members of the assessment committee

Prof. Rien Herber holds the position of professor in Geo-Energy at the Energy and Sustainability Research Institute of the University of Groningen. After graduating as a geophysicist in Utrecht University in 1979 he started his career in Shell in the research lab in Rijswijk. Following assignments in Brunei, Thailand and the Netherlands he moved northward to Norway as exploration manager for Norske Shell, during which period the deep water Atlantic Margin was opened. In 1998 he moved back to NAM as exploration manager. Still based in Assen, he was appointed in 2003 as Vice President Exploration for Shell in Europe. In this capacity he was responsible for the Shell operated exploration activities in the UK, Netherlands, Norway, Ukraine, Sweden and Ireland, non-operated Shell interests in Germany, Denmark and Italy as well as new exploration opportunities outside these countries. In addition to these responsibilities he has been Deputy General Manager of NAM since 2004 until mid 2009 when he left Shell to take up the professorship in Groningen. Herber is a member of the Dutch Mining Council since 2010.

Prof. Jan Hopmans is Professor of Vadose Zone Hydrology at the University of California, Davis. He graduated with a Master degree in Hydrology at Wageningen Agricultural University (Netherlands) in 1981 and received his PhD in 1985 at Auburn University (USA) in soil physics. He accepted a faculty position at the University of California, Davis, USA, in 1988. His research and teaching activities focus on the development of experimental and mathematical methods to better understand the fundamental processes controlling soil water flow and transport in the vadose zone across spatial scales, and include interests in pore-scale processes, soil water-plant relationships, irrigation water management at field and basin scale, and climate change impacts on CA hydrology. He has about 150 peer-reviewed publications in soil science and water resources journals. He is fellow of the Soil Science Society of America and the American Geophysical Union, and he received the 2003 Soil Physics Don and Betty Kirkham Award. He was past-chair of Department of Land, Air and Water Resources at UC Davis, and is currently Associate Dean of the College of Agricultural and Environmental Sciences, and Co-Editor of Vadose Zone Journal.

Prof. Des Walling recently retired as Reardon Smith Professor of Geography at the University of Exeter, UK and he is currently Emeritus Professor of Physical Geography within the College of Life and Environmental Sciences at Exeter. His research and teaching interests lie at the interface of Hydrology and Geomorphology, with particular reference to erosion, sediment transport and sediment budgets at both the catchment and global scale. He has a special interest in the use of fallout radionuclides for sediment tracing. He has published 34 books and edited volumes and more than 500 papers in journals and conference proceedings. He has maintained a strong involvement in international scientific activities throughout his career and he has served as President of the International Commission on Continental Erosion (ICCE), the International Association of Sediment Water Science (IASWS) and the World Association of Sedimentation and Erosion Research (WASER). He is currently a member of the Steering Committee of the UNESCO International Sediment Initiative. He was the recipient of the IAHS/UNESCO/WMO International Hydrology Prize in 2007 and the AGU Hydrological Sciences Award in 2008.

Prof. Martin Landrø is Professor of applied geophysics at the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. His main fields of interests are reservoir geophysics (including time lapse seismic), seismic inversion methods, rock physics, four-component seismic, marine seismic acquisition, analysis of CSEM data, and gravimetric methods for monitoring purposes. He is leader of the ROSE consortium at NTNU. This

consortium is focused on rock physics, geomechanics and various seismic methods. Present research activities include time lapse seismic in general, time lapse refraction methods, time lapse tomographic inversion, monitoring of CO2-storage, rock physics, modelling of air gun sources, using CSEM-data for monitoring purposes, and research related to improve understanding of salt. In 2009 Landrø launched a research project focusing on long term monitoring (LOSEM) of an old underground blow out (from 1989), where the objective is to investigate long term migration of gas through shallow sediments. Landrø currently serves as a member of the programme committee for the Norwegian Academy of Technical Sciences.

Drs. Renate Prenen is educational advisor and independent entrepreneur in educational advice. She studied Applied Educational Sciences at Twente University. She worked at Randstad employment agency as advisor and programme manager. Later, she worked at the Academic Medical Centre (AMC) of the University of Amsterdam, where she was educational advisor for the Board of the AMC. In September 2009 she started as an independent educational advisor. She has been a committee member on other QANU assessment committees.

Maaike Cazemier completed the Master's programme in Hydrology and Water Quality at Wageningen University in September 2012. In 2006 after finishing her pre-university education (VWO) at RSG De Borgen in Leek, she started her Bachelor Soil, Water, Atmosphere at Wageningen University. During the first two years in Wageningen, she was an active race-rower for Students Rowing Association Argo. In the following years, she was an active member of Study Association Pyrus where she was a board member (2009-2010) with responsibility for study matters. Furthermore, she was active in a number of committees both for the rowing association and the study association. In 2010 she was chairwoman of the committee that organised the 51st Argo short track races, a national rowing competition featuring some 250 rowing teams.

Appendix 2: Domain-specific framework of reference

Realization of the domain-specific reference framework for Earth Sciences

The domain-specific reference framework was created by the Chamber for Earth Sciences and educational administrators and/or heads of departments of university institutions with degree programs in the Earth Sciences. It evolved out of a number of joint meetings. The Chamber decided to formulate a general domain-specific reference framework applicable to all Earth Science programs in the Netherlands. Each institute is responsible for its own self-evaluation against the Dublin descriptors for the international positioning of its programmes. The current domain-specific framework is a modified version of the framework established in 2006. It takes into account society's rapidly growing demand for well-trained Earth scientists prepared to tackle scientific and societal issues. In updating the framework, use has been made of "Agenda 2020: Perspectives of the Earth Sciences", the outcome of a series of consultation workshops organized in 2009 by the Council for Earth and Life Sciences (RAL) of the Royal Netherlands Academy of Arts and Sciences (KNAW). Successful implementation of innovative fundamental and applied research often relies on input from various scientific disciplines, enabling cross fertilization of ideas. However, deepening of knowledge of a discipline is often one of the means to seek its boundaries. It is precisely at the interface between separate disciplines that crucial breakthroughs may be made. Both mono- and interdisciplinary training and education, as is the case for Earth Sciences, should therefore be stimulated. Demand for highly educated persons is currently strong and is expected to increase, with correspondingly good job opportunities for Earth scientists. The Dutch government has recently identified a number of key economic sectors in which industry, academia and (semi)governmental institutions should collaborate in fields relevant to society. Earth Sciences has a strong position in two of these nine key economic sectors: energy and water.

System Earth

Earth Sciences have the planet Earth as their object of study, its genesis and its quality of life. Knowledge is gathered about its origin, its current and former composition, structure, and the processes acting in and between the components geosphere, hydrosphere, atmosphere and biosphere. Equally important is knowledge of how to manage and sustainably use Earth's resources and understand the influence of human activity on the terrestrial system. It is of vital importance to gain insight into the wide range of time and spatial scales on which earth processes operate and are manifest. The study of Earth Sciences combines aspects of observation in different forms, via remote-sensing (air and land surface), field studies (surface/outcrop observations and measurements), measurements from within the Earth (e.g. seismology, earth material), analysis of data using laboratory methodology and techniques, and through developing and testing of concepts via computational modelling and simulations. Over the last couple of decades, increasing attention has been paid to the relationship between the Earth Sciences and society. The impact is clear in the fields of natural resource (energy – raw materials – water) evaluation, global climate evolution, the environment and natural and man-induced hazards. In The Netherlands, Earth Science knowledge is widely employed in the design of infrastructure in our heavily populated delta and in the use and management of the shallow and deep subsurface. This development has led to a replacement of the question "what does the Earth mean for humans?" by the question "what do humans mean for the Earth?" In other words: What roles do anthropogenic factors play in terrestrial and atmospheric processes and how can this knowledge be translated into governmental policies and societal action? Also, which measures can we take to incorporate, absorb or mitigate the consequences of man-induced changes in the Earth system? The rapid technological and computational innovations of recent years have created important new

challenges and opportunities for the development of Earth Sciences in general and for the training of a new generation of students and young scientists in particular. These technological innovations, partly initiated and stimulated by advances in the field of IT, in modern forms of observation, analysis and experimentation, visualization, simulation and modelling, along with improvements in data mining, technical data processing and data assimilation, have led to a broader and deeper insight into how the Earth system works and how we can be more effective in the use and management of the planet. Science is no longer conducted exclusively within the limits of one discipline and this applies equally to Earth Sciences, where physics, chemistry, biology/microbiology/ecology and applied mathematics/informatics are integrated. In an even wider perspective, Earth Sciences research is increasingly incorporating knowledge from the social sciences. The practice of the various Earth Science disciplines themselves is also characterized by an increasing integration and by multidisciplinary collaboration. Going beyond the boundaries of the Earth Sciences disciplines does not mean, however, that the role of specializations will decrease. Integration and specialization both demand attention if further development is to take place. Specialist depth remains essential to multidisciplinary research at high levels. Likewise, a good connection is essential between fundamental aspects and applied aspects.

The Earth system contains the following four subdomains:

Geosphere
The geosphere encompasses the solid part of planet Earth, from depths of a few 100s of meters, through the Earth's crust and mantle to its core. Most of it is inaccessible for direct, *in-situ* observation; hence predicting its architecture and physico-chemical properties is a challenging task. Large- and small-scale cycles and processes, heat exchange and movement of material take place between the different subcomponents and towards the surface and atmosphere, on a wide range of time and spatial scales. Plate tectonics, mountain range formation and erosion, geochemical differentiation and cyclicity, terrestrial material formation and deformation, strength and tension of and within materials, along with resources like energy, water and ores are all aspects of the Earth system that are directly linked to solid or deep Earth. Knowledge of the solid Earth comes from geological, geophysical and geochemical research in the following subdisciplines: tectonics, structural geology, seismology, experimental materials science and deformation, sedimentology, paleomagnetism, petrology, volcanology, thermodynamics and isotope geochemistry.

Surface
The subdomain 'Surface' covers the shallow subsurface, to a maximum depth of several hundred meters, the Earth's surface and the lower part of the atmosphere (Troposphere). Processes and developments in the deep Earth (endogenous processes) serve as boundary conditions for the working and effectiveness of physical, chemical and biological processes at the Earth's surface. Exogenous near-surface processes between the atmosphere and the Earth's surface layer involve complex, non-linear interactions acting on a wide range of temporal and spatial scales. Flow of matter plays a crucial role in this subdomain, whether in the form of particles or in the form of solutes or gasses. Such flows, via surface and groundwater in the biosphere and soil, are responsible for the further development of the terrestrial relief through erosion and sedimentation, the development and maintenance of natural ecosystems and changes in physico-chemical properties of soils. The Earth's surface is the habitat of man, where there is a strong link between human activities and natural processes, e.g. concerning the use of the underground to realize infrastructural projects, the production of agricultural crops and, on a larger scale, concerning the consequences of "climate change" for landscape and society, in the form of sea level rise and changes in land

use. Relevant subdisciplines include soil science, physical geography, geology, biogeochemistry, sedimentology and hydrology. Further distinctions can be made: soil chemistry and physics, geomorphology, hydrodynamics, Quaternary geology, hydrology/geohydrology/ecohydrology, soil and microbiology, landscape ecology, geo-informatics and geostatistics.

Biosphere-hydrosphere-atmosphere
Physical and chemical processes determine the status of the atmosphere and the water and element cycles that interact directly with the Earth's surface (vegetation, soil, surface water). This interaction is partly determined by climate variability and change, and partly by land use. Water infiltrating into the surface not only provides a means of subsistence (store of drinking water, irrigation water), it is an important conditioning factor for a large series of linked physical, chemical and biological/microbiological processes in the soil and shallow subsurface. The flow of the water at the land surface ensures the transport of particulate and dissolved substances (nutrients, contaminants, trace elements) from the land surface via the rivers to the oceans. Water and climate processes, acting over a range of temporal and spatial scales, are vital to the Earth's biosphere. This is also true for the interaction between the lithosphere and the biosphere. An important element is the crucial role played by the biosphere in maintaining or changing the biogeochemical functioning of the Earth. The primary subdisciplines of this domain are: meteorology, air quality/atmospheric chemistry, climatology, physics and soil physics, hydrogeology, hydraulics, environmental hydrology, landscape ecology, ecology (including aquatic ecology), geobiochemistry, biology/microbiology, paleontology, geoinformatics, and paleoceanography/marine sciences.

Applied Earth Sciences
Applied Earth Sciences are concerned with the part of the Earth that interacts strongly with society, namely the upper few kilometres of the Earth's crust. This layer hosts the largest part of our resources (from water to ore minerals) and supports an increasing number of infrastructural interventions. In this domain, sedimentological, tectonic, and other natural processes have a profound impact on engineered and other manmade structures, ranging from tunnel building to excavations and constructions. Sustainable management of this delicate outer shell of the Earth requires a combination of highly sophisticated tools to image the Earth's subsurface at depths of tens to thousands of meters, and a profound understanding of the phenomena involved. Exploration and exploitation, as well as processing and recycling, of terrestrial materials (including oil and gas) require the ability to develop and employ prudent and environmentally friendly engineering approaches to the use of the Earth and its subsurface resources. This means that not only geological processes and systems, but also the fundamentals of processes imposed by man, like fluid flow through porous media, geophysical and petrophysical exploration techniques, geomechanics for deformation, strength and tension in rocks and soil, chemistry for mining, metal production, and recycling of materials should be taught. To study these processes, considerable attention is paid to the observation, analysis, and processing techniques themselves. The study of Applied Earth Sciences has a strong geological component and involves the primary subdisciplines: applied geophysics, petroleum engineering, reservoir geology, geo-engineering and resource engineering.

Place of Earth Sciences in society
It is very important that degree programs reflect the current working environment and the application of the Earth Sciences in modern society. Potential employers include universities, government and semi-government agencies, consultancy firms and industry. The different fields of application are:

Natural resources
This covers the application of existing, as well as development of new technologies for the geological and geophysical exploration of natural resources present in the continental subsurface and below the sea, and the sustainable, environmentally responsible management and use of these resources. Examples of natural resources include: industrial minerals, water for human consumption and food production, energy, raw materials and soil (food supply). In the future, particular attention will be paid to the scarcity of resources and to the energy transition.

Terrestrial space
Sustainable management of the subsurface, natural ecosystems and aboveground space are essential to man's future existence. The shallow underground is being increasingly used for laying infrastructural facilities (cables, tunnels, transport lines, etc.), the building of utilities (storage of goods, shopping centers, waste products, etc.) and the storage of energy (thermal, potential, etc.), of energy carriers (e.g. gas) or of residues (CO2, etc.). In many regions the use of land is intensifying and changing. On a global scale there is excessive population growth in deltas, coastal areas and along rivers. This creates intense pressure on the use of these areas and the atmosphere. Earth Science expertise is essential to the management of these areas. Given the many possible uses for the subsurface (e.g. support for constructions, substrate for agriculture and nature, source of minerals, ecological cleansing of groundwater and contaminated soil, etc.), there is also a connection with environmental planning.

Functioning of terrestrial (eco)systems
This field covers, on the one hand, the influence of human activities on soil, water and atmosphere and, on the other hand, natural variations in the quality of the terrestrial environment, including undisturbed (eco)systems. Earth Science expertise and knowledge are essential for both aspects, as well as to our ability to sustain the quality of life and our environment. For the management and removal of contaminants in the terrestrial environment, like the cleaning up of polluted terrains or waste disposal, knowledge and expertise in the fields of civil, chemical and microbiological technology are required.

Natural and man-induced hazards
This field covers the study and analysis of natural hazards like earthquakes, tidal waves, hurricanes and tornadoes, floods and droughts, tsunamis and volcanic eruptions, as well as risks resulting from human activities, like subsidence due to the extraction of groundwater or oil and natural gas, interventions in the courses of rivers, creating recreational and residential areas in vulnerable regions, etc. Most importantly, the risks resulting from climate change belong to this field of application. It is particularly in this area that sound Earth Science knowledge is required input for policy measures at local authority, provincial and national government levels. Safety is an increasingly important dimension in our society.

Earth Sciences as auxiliary science
Another field of application of the Earth Sciences is as an auxiliary science. Modern Earth Sciences (with its tendency towards exact, quantitative aspects) form a foundation for other disciplines, like ecology, archaeology and geobioarchaeology, agricultural and environmental sciences, oceanography and meteorology, in the same way as e.g. physics, chemistry and biology have affected the Earth Sciences.

General objective of a degree programme in Earth Sciences

The general objective of the university programmes is to produce graduates capable of conducting activities appropriate to the broad field of Earth Sciences at the academic level. These activities include research (fundamental, strategic or applied science), development, advisory, didactic or implementation activities. The modern Earth scientist should be equipped with knowledge of terrestrial processes in order to i) determine or predict the present architecture and physico-chemical properties at the surface, lower atmosphere and shallow to deep subsurface and how this controls human activities, and ii) understand and predict how natural and/or man-induced processes will impact our environment. The need for further insight into terrestrial processes requires understanding of a broad spectrum of spatial and time scales and an approach which pays attention to the interaction of and between the various terrestrial subdomains.

Objective of a bachelor degree programme in Earth Sciences

Earth Sciences is a broad science, which examines the processes and patterns found on the Earth's surface in the deep and shallow subsurface and in the atmosphere. This science is strongly interdisciplinary, with interaction between various factors, such as humans, animals, relief, soil, water, lithology, atmosphere, hydrosphere and vegetation. The three-year bachelor's programme in Earth Sciences teaches the student knowledge and skills in the field of the 'Earth system' in a broad sense, and in one of the four subdomains in particular. The programme focuses on learning to understand patterns and processes, including applications, using modern techniques like geo-informatics, simulation and modelling. It is very important that a bachelor graduate in Earth Sciences has experience with both field and laboratory studies. After completing a bachelor's programme in Earth Sciences the student has:

- Knowledge and insight into terrestrial and/or atmospheric processes, the fundamental mechanisms underlying these processes, and the resulting patternsand systems.
- Insight into the place that the Earth Sciences occupy in relation to other fields of science.
- Insight into the activities and responsibilities of an Earth scientist.
- Knowledge of techniques used in the description and interpretation of Earth Science phenomena in and on the Earth's crust: sampling, analysing, simulating and modelling data.
- Skills in application of the research techniques most commonly used in the Earth Sciences and an ability to learn new techniques. This refers especially to measurement techniques used in the laboratory or in the field, and analysis techniques and software used for the acquisition, storage, analysis and modelling of the data.
- Basic skills in preparing a research plan, defining and formulating a problem, collecting relevant background information (literature search) and collecting and processing data.
- Ability to report clearly on scientific research both orally and in writing.
- Ability to work independently as well as in a team.
- Ability to collaborate with scientists from allied disciplines.
- Ability to defend own viewpoint and willingness to revise that standpoint after scientific discussion.
- A socially responsible attitude towards the sustainable use of natural resources and the terrestrial environment.

Objectives of a master's degree programme in Earth Sciences

The objectives of a master programme in Earth Sciences are to impart to the students the knowledge, attitudes, skills, and insights which render the graduate master (1) capable of

practicing his/her profession independently, or (2) qualified for continuing training in scientific research. The graduate master should be competitive in his/her field on the international labour market, both for employment in trade and industry or government and within PhD-research programs at international scientific institutions. After completing a master's programme in Earth Sciences the student:

• Has specific theoretical and practical knowledge of the Earth Sciences, notably within the field of his/her specialization, such that he or she can start and successfully complete a PhD thesis or to take up a position at an academic level with government or government-related institutions, with private companies, or elsewhere.
• Is experienced in carrying out research. This experience has been gradually developed through the confrontation with research and with active researchers, and through active participation in research, in a manner that enables the student to consciously decide whether he/she prefers to continue his/her studies in order to obtain a PhD degree or to take up a position outside the academic world with or without a doctoral degree.
• Is able to function in his/her discipline at an academic level, both in way of thinking and in daily practice; has been stimulated to work on his/her personal development, notably regarding consciousness, independence, communicative behaviour and attitude towards co-operation.
• Has recognized the need to continue his/her education; the graduate is aware of the need to keep in touch with relevant developments within his/her discipline, and is prepared to realize this (lifelong learning).
• Has gained insight into the broad historical, philosophical and social context of the discipline and aspects concerning the intellectual integrity and moral and ethical dimensions of scientific research and its applications.
• Is able to successfully compete on the international labour market.

In the Master programme the students should obtain three
levels of expertise:

• *Knowledge*: This comprises a basic understanding of the theory and scientific principles behind the theme or techniques taught, and an appreciation of when and how it can be appropriately used or applied. It does not imply that the student will work intensively with it in the programme itself. The group of courses that reach only the *knowledge*-level are generally restricted to the first year of the master.
• *Practical capability*: This means that at some point during the programme, usually at the beginning of the second master year, the student will have achieved a deep enough knowledge of a (group of) theme(s) or technique(s) that the student can demonstrate that he/she is in a position to apply this knowledge. In essence this means that this particular theme or group of themes will lie in the student's specialist direction.
• *Mastery*: Students will be expected to demonstrate that in at least one theme, they have carried out a research project (e.g. a field-based project) and produced a thesis document. This project may be done in Critical reflection BSc Soil, Water, Atmosphere 2011 | Wageningen University | 33 cooperation with other students but needs to comprise results adding to fundamental scientific knowledge. It should demonstrate the use of intellectual and creative skills as well as a working familiarity with current expertise in the subject, thereby contributing to it, for instance through the modification and further development of existing modelling tools. The mastery level is applicable to the Master-thesis.

Appendix 3: Intended learning outcomes

Bachelor's programme

General

1. The graduate has knowledge, overview and understanding of the properties and structure of the Earth and the operation of system Earth as an arrangement of layers (spheres): lithosphere, hydrosphere, biosphere and atmosphere), cycles of matter, endogenous and exogenous dynamics.

2. The graduate has knowledge and understanding of the elementary processes of rock formation, the structure, composition, division and classification of rocks, stratigraphic principles and time scale, and sedimentation and deformation processes and products.

3. The graduate has sufficient spatial awareness to represent geological and physical geographic elements on maps, to understand and analyse them, to translate aerial images and analyses to such maps, and to execute simple cartographic and profile structures.

4. The graduate is able to think at a large scale of space and time in the earth sciences, such that geological and physical geographical / geomorphological processes and phenomena can be distinguished by shape, formation process, place and time.

5. The graduate has knowledge and understanding of analysis techniques for terrestrial materials.

6. The graduate has extensive knowledge of the exact sciences (mathematics, physics, chemistry), as required for further specialization in the next academic phase.

7. The graduate is able to apply simple quantitative methods, i.e. translate a real scientific problem into a mathematical model and perform calculations on this model, with or without the help of a computer.

8. The graduate is conversant with computer programs such as word processing, spreadsheets, databases and graphing software.

9. The graduate has developed sufficient skills in the use of data processing systems and geographic information systems.

Knowledge and understanding

The graduate has demonstrated knowledge and understanding in a field of study that builds upon and their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study.

Solid Earth (Specialization I)

1.The graduate has specific professional knowledge of the geological components of the Earth sciences, specifically in the field of Mineralogy and Petrology, Structural Geology and Historical Geology.

Earth's Surface (Specialization II)

1. The graduate has specific professional basic knowledge of the physical geographic/geomorphologic components of the Earth sciences, specifically in the field of Geomorphology, Quaternary geology, Soil Science and Geobotany.

Applying knowledge and understanding in practice
The graduate can apply his/her knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences2 typically demonstrated through devising and sustaining arguments and solving problems within their field of study.

1. The graduate can systematically collect data through direct observation in the field and from aerial photographs on the basis of clear geological and geomorphological questions; is capable of coherently combining these observations and interpreting them on maps and in profiles or in other databases and of processing the observations in a scientific report that meets the faculty guidelines.

2. The graduate has acquired initial experience in scientific research; said experience is developed in the course of the programme by means of encounters with research and researchers and subsequently by means of active participation in a supervised research project.

3. The graduate is capable of defining a specific Earth sciences research question, establishing hypotheses and explanations and designing a strategy for a solution and of implementing this strategy (problem solving skills).

4. The graduate is capable of multidisciplinary thinking and can make connections between different informational content.

Making judgements
The graduate has the ability to gather and interpret relevant data (usually within their field of study) to inform judgements that include reflection on relevant social, scientific or ethical issues.

1. The graduate is capable of appreciating the value of field data and/or lab data and can assess their applicability.

2. The graduate is capable of assessing whether quantitative models are applicable.

3. The graduate is capable of reading, comprehending and critiquing non-specialist journals and reports in the field of the Earth sciences.

4. The graduate understands the domain of the Earth sciences and the existence and significance of specific, adjacent professional areas.

5. The graduate understands the scope, application and responsibilities of the field and the role of Earth sciences in science, society and professional practice.

6. The graduate is capable of giving due consideration to the ethical aspects of science and its applications.

7. After the first year, the student has sufficient understanding of the entire field and his or her own performance to be able to decide whether a follow-up programme would be wise.

8. The graduate is capable of making informed choices about further specialization in the next academic phase (Master's programme) or about entering the labour market.

Communication

The graduate can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

1. The graduate is capable of clearly presenting knowledge and understanding orally and in writing.

2. The graduate is capable of forming an opinion and defending a position.

3. The graduate is capable of working in a group.

Learning skills

The graduate has developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy

1. The graduate is cable of independently studying non-specialist literature in the Dutch and English languages.

2. The graduate is capable of functioning in an international environment during research projects and can work both independently and in a group.

3. The graduate functions at an academic level in his or her field and has learned the value of continuing education.

4. The graduate is capable of and recognizes the need to keep abreast of relevant developments in his or her field.

Master's programme in Earth Sciences

General

1. The graduate has specific and fundamental theoretical and practical knowledge of Earth science processes, notably within his/her field of specialisation, as a basis for predicting the further course of processes, including the role of mankind now and in the future. The need for insight into Earth processes requires further deepening of basic knowledge, understanding of a broad spectrum of spatial and temporal scales and an approach focusing on the interaction by and between the various Earth domains.

2. The graduate has experience in carrying out research independently. This experience is gradually developed within the programme through exposure to research and interaction with active researchers and, ultimately, through active participation in research. This occurs in such a way that it allows the student to consciously decide whether he/she prefers to continue his/her studies in order to obtain a PhD degree or to take up a position outside the academic world.

3. The graduate functions in his/her discipline at an academic level, both mentally and in daily practice; the programme stimulates the social and personal development of the student by motivating societal awareness, independence, communicative behaviour and co-operation.

4. The graduate recognises the need to continue his/her education by following relevant developments within the field of Earth sciences to maintain a state-of-the-art know-ledge basis, and is prepared to realise this.

5. The graduate is able to start and successfully complete a PhD thesis or to successfully compete in the (inter-) national labour market for positions at an academic level with government or government-related institutions, private companies, or elsewhere.

6. The graduate has insight into the broad historical, philosophical and social context of the discipline and aspects concerning the intellectual integrity and moral and ethical dimensions of scientific research and its applications.

Knowledge and insight
The graduate has demonstrated knowledge and insights in a field of study that builds upon and their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study.

General
The student has a basic understanding of the theory and scientific principles behind the theme or techniques taught, and an appreciation of when and how it can be appropriately used or applied.

Depending on the track followed the graduate has:
(1) and (2) *Palaeoclimatology and Geo-Ecosystems* and *Applied Environmental Geosciences*
• a substantial knowledge of climate systems that operated both in the past and at

present, and the interactions of the different components of the climate system;
• knowledge of the different components (ice, atmosphere, land and oceans) of the climate regime and their properties and how they interact;
• knowledge of changes that (presently) occur at the land surface and the interaction with climate and environmental variation at different spatial and temporal scales;
• understanding of the processes that regulate the transfer of energy, water and trace gases between the land surface and the atmosphere;
• good theoretical understanding of mathematics, physics, chemistry and statistics in relation to geo-environmental sciences.

(1) Palaeoclimatology and Geo-Ecosystems:
profound knowledge of the proxies employed in palaeoclimate and geo-ecosystem research.

(2) Applied Environmental Geosciences:
• substantial knowledge of hydrology and/or Geographical Information Science, Remote Sensing techniques;
• profound knowledge of the methods applied in environmental geosciences.

(3) Earth Sciences and Economics
• basic knowledge of basin assessment;
• a profound knowledge of economic principles on spatial policy making and landscape assessment;
• good theoretical understanding of Geographical Information Science, Remote Sensing and Decision Making techniques.

Depending on the focus the graduate has profound knowledge of:
• climate systems and their interaction to geo-ecological systems, man, policy making and spatial economics;
• the water cycle interacting with the elements of ecosystem functioning, land use, spatial economics and policy;
• energy systems, especially geothermal, its policy and spatial economics.

(4) and (5) *Archaeometry* and *Landscape archaeology*
• a thorough knowledge of Geographical Information Science, Remote Sensing techniques;
• a broad and thorough knowledge of the most important categories of inorganic and organic archaeological finds;
• a basic knowledge in biological (biomolecular) archaeometry;
• knowledge of geophysical and geological methods in order to trace archaeological sites and sources of raw materials from the past.

(4) Archaeometry:
• a thorough knowledge of categories of anorganic and organic archaeological finds;
• a thorough knowledge of biological archaeometry (including archaeozoology);
• a thorough knowledge of geochemical processes and analysis techniques;
• a thorough knowledge of hydrology and hydrochemical processes.

(5) Landscape archaeology:
• a thorough knowledge of geobotanics, plaeo-ecology, including palynology and palaeo-ecological environments in order to make landscape reconstructions independently;
• a thorough knowledge of Dutch landscape types.

(6) Solid Earth
• a regional knowledge of worldwide geological systems and their settings;
• knowledge of relationships between deeper processes (subduction, metamorphism, magmatism) and related surface expressions and sedimentary sequences;
• knowledge of processes of heat transport and fluid flow, and regional scale lithosphere deformation;
• knowledge of interpretation techniques of subsurface geophysical and geological data;
• knowledge of thermochronological methods and their applications.

Applying knowledge and insight in practice
The graduate can apply his/her knowledge and insight in a manner that indicates a professional approach to their work or vocation, and have competences2 typically demonstrated through devising and sustaining arguments and solving problems within their field of study.

The student has achieved a deep enough knowledge of themes or techniques that (s)he can demonstrate that (s)he is in a position to apply it. In essence it means that this particular theme or group of themes will lie in the student's specialist direction.
The graduate is able to:

• formulate a problem based on raw data and/or data from a literature study and design a sound, scientific, approach for researching and solving the problem;
• formulate a research proposal, which includes the problem formulation, the hypotheses, the proposed execution and the finalisation of the project;
• develop (conceptual) models suited for the testing of hypotheses and to give explanations;
• collect and critically compile the literature significant to a specific topic to be studied;
• operate within a multidisciplinary framework and to connect different types of factual information.

(1) and (2) *Palaeoclimatology and Geo-Ecosystems* and *Applied Environmental Geosciences*
• unravel a sedimentary archive embedding climate and geo-environmental signals, by employing an array of techniques;
• contact affiliated departments to perform certain techniques, not available in our Institute.

(1) Palaeoclimatology and Geo-Ecosystems
• translate and quantify ongoing processes at the land surface that generate climate change into changing boundary conditions for climate modelling;
• discern the various physical and biogeochemical processes that contribute to (future) climate change and their impact on man sustainability;
• use his/hers knowledge and insights in the political debate on the role that future climate developments play.

(2) Applied Environmental Geosciences
• perform geo-scientific environmental analyses and reconstructions.

(3) Earth Sciences and Economics
• apply and understand economic evaluation tools for policy assessment, e.g. CBA and MCA;
• apply GIS, RS and decision making techniques on relevant Earth-Sciences-and-Economical problems, and understand the interactions at the disciplinary interfaces;
• bridge the gap between industry, academia, government agencies and NGO's in dealing with resource and water management, risk assessment, land use and ecosystem services;
• understand the positions in the political debate on the management of natural resources, water and landscape.

(4) Archaeometry
• recognise and monitor contamination and degradation processes of archaeological materials;
• reconstruct ancient technologies and production processes and to understand trade patterns and the use of raw materials in general;
• apply the knowledge of the role that preservation of the archaeological cultural heritage plays in the political debate;
• apply the knowledge of the current archaeological polity concerning research and in-situ preservation of the archaeological cultural heritage;
• work with the methods of current Dutch contract archaeology.

(5) Landscape archaeology
• independently apply palaeo-ecological and geological methods and techniques for landscape reconstructions;
• interpret the current Dutch landscape in terms of geological and geomorphological processes, environments and landforms;
• interpret reconstructions of landscape and environment in terms of possibilities for settlement- and use for Prehistorical humans;
• use geological and palaeo-ecological data in order to understand processes of degradation, threats and in-situ preservation of the archaeological heritage;
• interpret and apply results of geophysical and geochemical surveying techniques.

(6) Solid Earth
• apply fieldwork skills, i.e. linking theoretical knowledge and factual information to real sight observations, such as three dimensional scenes of geological structures on outcrop scale or in landscape view;
• apply analogue and/or numerical modelling techniques associated with the subject of specialisation.

Critical judgement
The graduate has the ability to gather and interpret relevant data (usually within their field of study) to inform judgements that include reflection on relevant social, scientific or ethical issues.

The graduate:
• understands professional literature and judge its quality and usefulness for own research;
• is able to determine independently which data or methods are required to obtain a specific result (or to finish a project);
• has an understanding of the subject area's limits, i.e. realize that at a certain stage other expertise should be brought in, or that there is a need for interdisciplinary co-operation;
• has an understanding of his/her personal stronger and weaker points, affinities, development potential and preferences in relation to the discipline chosen and the related professional potential;

• is able to consciously decide whether he/she prefers to continue his/her studies in order to obtain a PhD degree or to take up a position outside the academic world;
• is able to recognize and to judge ethical aspects of science and of the application of science.

Communication
The graduate can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

The graduate is able:
• to complete a report on trainee work, subject matter studied, or research carried out, that meets the requirements of an international scientific journal;
• to clearly present information, both written and orally to a public of specialists from the same subject area, on a topic that was independently studied (in English);
• to read publications and reports in his/her native language and in English;
• to contribute in international scientific forums;
• to actively and constructively participate in discussions and meetings;
• to operate individually as well as to co-operate in small international and multidisciplinary working groups at a level that is at the frontier of the subject area of study;
• to apply her/his knowledge in such a way that it demonstrates a professional attitude towards her/his work or profession.

Learning skills
The graduate has developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy.

The graduate has developed skills:
• to independently collect and to critically compile the literature significant to a specific topic to be studied;
• to use modern techniques to maintain his knowledge up-to-date;
• to read and understand the specialisation's specific journals, as well as the more general natural sciences journals such as Nature and Science;
• to recognize the need to continue his/her education (the graduate is aware of the need to keep in touch with relevant developments within his/her discipline, and is prepared to realize this);
• to be able to get acquainted with one of the other specialisations within the subject area in the course of a few months;
• to be able to get acquainted within a reasonable time with a subject area within the discipline which is different from the one of the degree programme.

Knowledge and insight

The graduate should have specialised theoretical and practical knowledge of the science of hydrology

The graduate has profound knowledge of and insight in:
• hydrological terminology and theory that is required to understand the development of new hydrological theory and research issues that are presently deemed of major importance in hydrological sciences;
• all aspects of the global water cycle and the role of the hydrological cycle in the Earth's climate system;
• theory of groundwater and surface water flows, soil physics, and the surface energy balance (evaporation theory);
• the dynamic response of groundwater and surface water to short and long-term variations in climate (e.g. rainfall and drought events);
• hillslope processes leading to the generation of overland flow, stormflows, surface erosion and sediment delivery;
• how water interacts with soil, rock, vegetation and the atmosphere and how this affects the chemical composition and nutrient fluxes (weathering, dissolution and deposition processes);
• the impacts of various land-use changes on groundwater recharge, catchment water and sediment yields, streamflow regime, and stormflow production;
• mathematics, physics and chemistry that conforms to the standard needed to conduct modern hydrological research;
• programming and modelling techniques for solving water quantity and quality issues;
• important hydrological methodology and instrumentation; including familiarity with state-of-the-art models for soil water and groundwater transport, runoff and sediment generation, soil-water-vegetation exchange simulation, and reactive
transport of pollutants;
• measurement techniques related to the exploration of groundwater (geophysics, tracer methods);
• the links between hydrology and related sciences (earth and soil sciences, ecology, microbiology, physics, meteorology).

Application of knowledge and understanding

The graduate should be experienced in carrying out research. This experience is developed through the confrontation with research and active researchers and through active participation in research
The graduate should be able to apply scientific knowledge to problems raised in society

The graduate is able to:
• formulate a problem based on raw data and/or data from a literature study and design a scientific approach for researching and solving the problem;
• formulate a research proposal, including problem definition, hypotheses, proposed execution and finalisation of the project;
• independently set up and execute a new hydrological field experiment;
• select the appropriate and most efficient techniques for field and laboratory data collection;
• apply these techniques to independently collect data for the formulation and testing of hypotheses;
• develop conceptual and physical models suited for the testing of the hypotheses;
• validate and calibrate hydrological or other models as required;

• select and obtain information as required for the study and be able to see connections between and draw conclusions from different data-sets;
• apply hydrological knowledge to solve problems related to the use of water in society;
• to start and successfully complete a PhD study;
• to successfully compete in the (inter)national market for positions at an academic level with government(-related) institutions, private companies, or elsewhere.

Critical judgment
The graduate should be able to independently and critically judge information
The graduate should be able to think within a multidisciplinary framework
The graduate has an understanding of his/her personal strong and weaker points.

The graduate should:
• understand professional literature and be able to judge its quality and usefulness for his/her own research;
• be able to analyse existing hydrological research projects with respect to the planning, execution and evaluation of the results;
• understand the role of hydrological sciences within earth sciences, natural sciences and engineering sciences, and be aware of how hydrological knowledge can be used to improve overall societal well-being;
• know the limitations of hydrological instruments and measurement techniques and how to take these into account when critically evaluating his/her own measurements;
• think in a multidisciplinary way and recognise the importance of other (sub)disciplines for his/her own specialisation and combine different types of factual information;
• have an understanding of the subject area's limits, *i.e.* realise at what stage additional expertise is needed;
• have an understanding of his/her personal strengths and weaknesses, affinities, development potential and preferences in relation to the discipline and related professional potential;
• be able to consciously decide whether he/she prefers to continue his/her studies in order to obtain a PhD degree or to take up a position outside the academic world;
• be able to recognise and judge ethical aspects of science and its application.

Communication
The graduate should be able to transfer knowledge and skills related to his/her subject area to other persons and to adequately reply to questions and problems posed within society

The graduate should be able to:
• complete a report on trainee work, subject matter studied, or research carried out;
• clearly present information, both written and orally to a public of specialists from the same subject area on an independently studied topic (in English);
• read publications and reports in his/her native language and in English;
• actively and constructively participate in discussions on hydrological issues and meetings; work together with one or more colleagues with different scientific backgrounds;
• translate his/her scientific findings into a language that is understandable for managers of water resources, policymakers and the general public.

Learning focus

The graduate should develop learning skills that enable him/her further self education and development within the subject area

The graduate should function in his/her discipline at an academic level, both mentally and in daily practice.

The graduate is able to:

• independently collect information on hydrological subjects and analyse, summarise and critically evaluate this information;

• use modern techniques to maintain his knowledge up-to-date;

• read and understand scientific hydrological journals, as well as the more general natural sciences journals such as *Nature* and *Science*;

• recognise the continued need to keep in touch with relevant developments in his/her discipline, and is prepared to take the appropriate action to realise this;

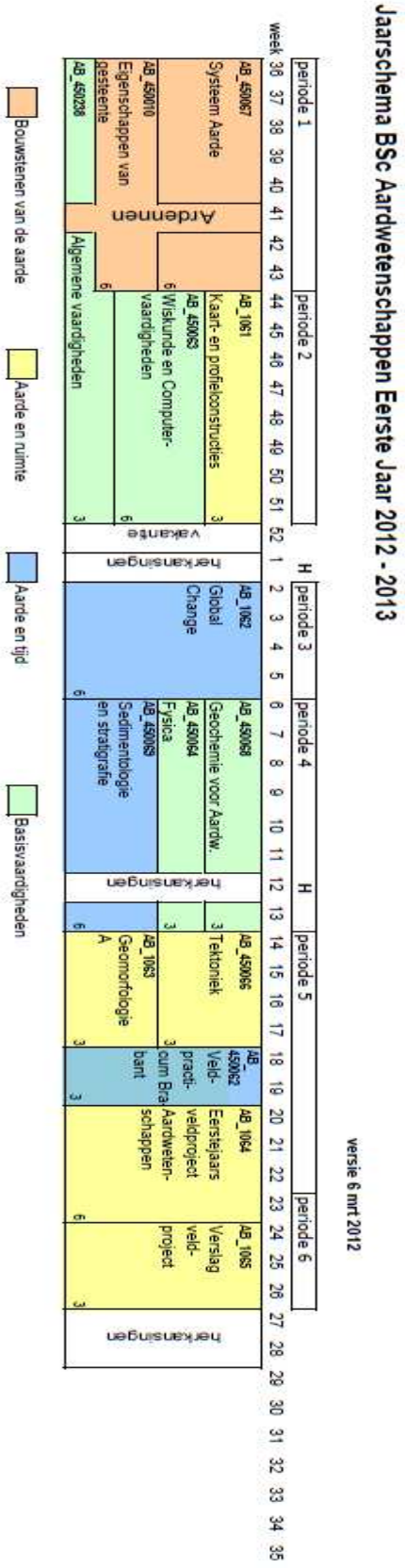
• recognise cultural and gender-related aspects of water issues;

• have an understanding of the existence and significance of related subject areas;

• to become acquainted with another water-related specialisation within the course of a few months;

• to become acquainted within a reasonable time, with a subject area different from the one of his/her own degree programme.

Appendix 4: Overview of the curricula



Jaarschema BSc Aardwetenschappen Tweede Jaar 2012 - 2013

versie 15 aug 2012

Richting: Aardoppervlak

periode 1									periode 2												periode 3				periode 4											periode 5												periode 6											
36	37	38	39	40	41	42	43		44	45	46	47	48	49	50	51	52	1			2	3	4	5	6	7	8	9	10	11	12	13					14	15	16	17	18	19					20	21	22	23	24	25	26					27	28	29	30	31	32	33	34	35
AB_450071 6 Statistiek en data-analyse									AB_1073 6 Sedimentaire systemen en geologie en landschap van NL en de Noordzee								vakantie	herkansingen			AB_450336 6 Inleiding anorganische chemie				AB_450091 Bodemkunde						herkansingen	3				AB_1077 6 Geomorfologie B en kwartair-geologie				AB_1078 (3) Veld-practicum Aard-oppervlak				AB_1079 6 Veldproject Aardoppervlak				AB_1075 3 Verslag veldproject jaar 2				Herkansingen								
AB_1072 6 Inleiding mineralogie en structurele geologie A									AB_450073 6 Wis- en natuurkunde																AB_1074 Inleiding hydrologie en klimatologie							6																															
																									AB_1076 GIS							3																													
																									hoort bij AB_1075 Studie en loopbaan																																				

Richting: Vaste Aarde

periode 1									periode 2												periode 3				periode 4											periode 5												periode 6											
36	37	38	39	40	41	42	43		44	45	46	47	48	49	50	51	52	1			2	3	4	5	6	7	8	9	10	11	12	13					14	15	16	17	18	19					20	21	22	23	24	25	26					27	28	29	30	31	32	33	34	35
AB_450071 6 Statistiek en data-analyse									AB_1073 6 Sedimentaire systemen en geologie en landschap van NL en de Noordzee								vakantie	herkansingen			AB_450336 6 Inleiding anorganische chemie				AB_1080 Structurele geologie B						herkansingen	3				AB_1081 6 Mineralogie en petrologie				AB_1082 (3) Veld-practicum Vaste Aarde				AB_1083 6 Veldproject Vaste Aarde				AB_1075 3 Verslag veldproject jaar 2				Herkansingen								
AB_1072 6 Inleiding mineralogie en structurele geologie A									AB_450073 6 Wis- en natuurkunde																AB_1074 Inleiding hydrologie en klimatologie							6																															
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gezamenlijk programma

Aardoppervlak

Vaste Aarde

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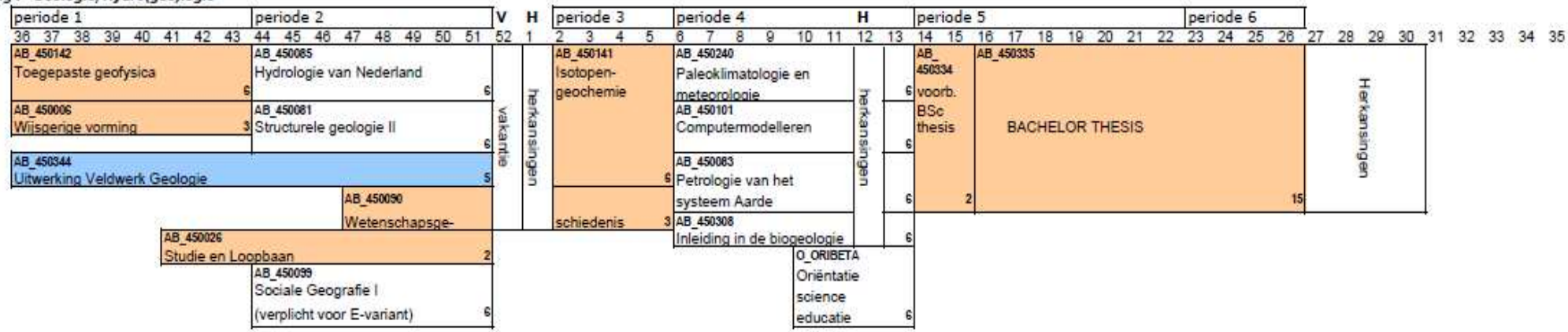
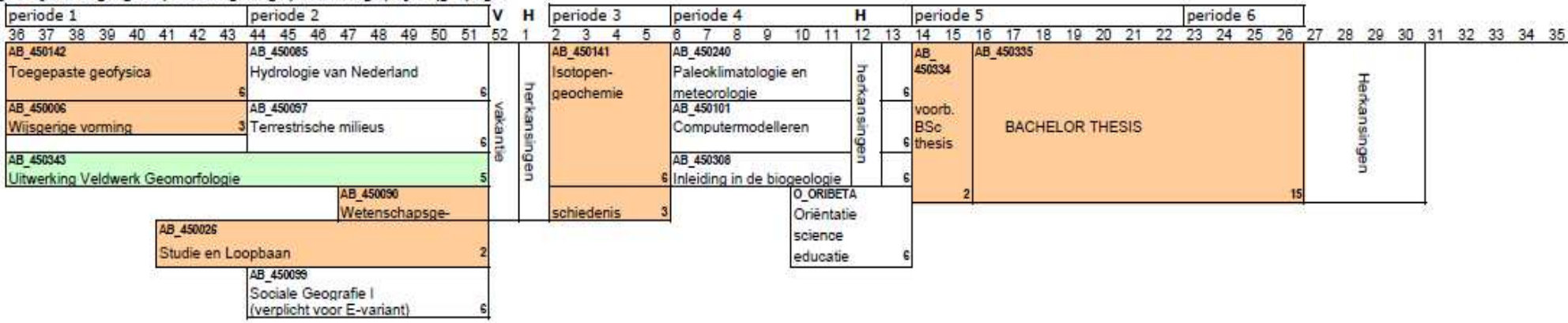
versie 15 aug 2012

Richting I - Geologie, Hydro(geo)logie



Richting II - Fysische geografie, Kwartairgeologie, Geoecologie, Hydro(geo)logie



Tables: Course info, exams and reports

Opleiding		Course code	Course title	cursuscoördinator	handout	Exams: Q	Exams: A	Exams: filled out	Exams: other	Literature
Bachelor courses Aardwetenschappen										
B A	**jr 1**	AB_450238	Algemene vaardigheden	dr. A.C. Lankreijer	y			y	reports	
B A	**jr 1**	AB_1064	Eerstejaars veldproject Aardwetenschappen	dr. B. Andeweg	y					
B A	**jr 1**	AB_450010	Eigenschappen van gesteenten I	dr. F.M. Brouwer	3x + syllabus	y	y	y		
B A	**jr 1**	AB_450064	Fysica voor aardwetenschappers	dr. B.P. Zoetemeijer	y	y	y	y		Physics - Giancoli
B A	**jr 1**	AB_1063	Geomorfologie A + GIS	dr. R.T. van Balen	y	y	y	y		book: Fundamentals of geomorphology - Huggett
B A	**jr 1**	AB_1062	Global change	dr.. M.J. Waterloo						
B B	**jr 1**	AB_1061	Kaart- en profielconstructies	dr. H. Stel	y	y	y			
B A	**jr 1**	AB_450069	Sedimentologie en stratigrafie	dr. H.B. Vonhof	y	y	y	y	practical exercises	
B A	**jr 1**	AB_450066	Tektoniek	dr. B. Andeweg	y	y				
B A	**jr 1**	AB_1065	Verslag veldproject Aardwetenschappen	dr. B. Andeweg	y				reports	
B A	**jr 1 / geo**	AB_450068	Geochemie voor aardwetenschappers	prof.dr. P.A.M. Andriessen	y	y	y			see handout
B A	**jr 1 / geo**	AB_450067	Systeem Aarde	dr. F.M. Brouwer	y + syllabus	part I	part I	part I		book: Dynamic Earth - Skinner, Porter, Park
B A	**jr 1 / geo**	AB_450062	Veldpracticum Brabant	dr. C.J. Beets	y	y	y	y	map	Atlas van Nederland in het Holoceen - Beukers
B A	**jr 1 / geo**	AB_450063	Wiskunde en computergebruik	dr. M. ter Voorde	y + syllabus	y	y	y		books: Wiskunde in werking - de Gee; Wiskundige methoden toegepast - Grasman
B A	**jr 2**	AB_450252	Geobotanie	dr. S.J.P. Bohncke	y				assignments	
B A	**jr 2**	AB_450251	Historische geologie incl. veldpracticum	prof. dr. J. Smit	3 parts	y	y		papers	
B A	**jr 2**	AB_450024	Inleiding hydrologie	dr. M. J. Waterloo						

B A	**jr 2**	AB_45007 2	Sedimentaire systemen in ruimte en tijd	prof. dr. J.J.G. Reijmer					5 articles	
B A	**jr 2**	AB_45007 7	Structurele geologie I, inclusief veldpracticum	~~dr. C. Biermann~~ dr. H. Stel (was Willingshofer)	y				practical assignments	
B A	**jr 2**	AB_45007 9	Veldwerk geologie	prof. dr. J. Smit				y (+mail)	field book (+maps), report	
B A	**jr 2**	AB_45009 2	Veldwerk geomorfologie	dr. C. Kasse	y					Montagnes du Jura - Bichet, Campy
B A	**jr 2**	AB_45025 0	Veldwerkverslag 1e jaar	dr. B. Andeweg						
B A	**jr 2**	AB_45007 3	Wis- en natuurkunde	dr. B.P. Zoetemeijer	y	y	y	y		
B A	**jr 2 / geo**	AB_45009 1	Bodemkunde	dr. C. Kasse	y	y	y			book: see Bodem en milieu
B A	**jr 2 / geo**	AB_45002 3	Digitale ruimtelijke data	dr. R.A.M. de Jeu	y	y	y	y	exercises	reader
B A	**jr 2 / geo**	AB_45009 5	Geomorfologie, inclusief veldpracticum	~~prof. dr. J.F. Vandenberghe~~ dr. R.T. van Balen						*see AB_1063*
B A	**jr 2 / geo**	AB_45033 6	Inleiding in de anorganische geochemie	dr. J.R. Wijbrans	y	y	y	y	assignments	book: Principles and applications of geochemistry - Faure
B A	**jr 2 / geo**	AB_45009 3	Kwartairgeologie/Kwartairgeologische landschappen van Nederland + veldpract.	dr. R.T. van Balen						book: De vorming van het land – Berendsen
B A	**jr 2 / geo**	AB_45007 8	Mineralogie	dr. W. van Westrene	y	y	y	y	assignments	Mineralogy - Dyar, Gunter, Tasa
B A	**jr 2 / geo**	AB_45007 6	Petrologie, incl. veldpracticum	dr. P.Z. Vroon	y	y	y	y	exercises	
B A	**jr 2 / geo**	AB_45007 1	Statistiek en data-analyse	dr. F.J.C. Peeters	y (2x)	part II	part II	part II		
B A	**jr 3**	AB_45010 1	Computermodelleren	dr. J. van Huissteden	syllabus and manual + pract. ass.				free assignment	
B A	**jr 3**	AB_45008 5	Hydrologie van Nederland	dr. J. Groen	y	y			posters; info exams comm.	2 articles, 1 chapter
B A	**jr 3**	AB_45030 8	Inleiding in de biogeologie	dr G.M. Ganssen						
B A	**jr 3**	AB_45014 1	Isotopengeochemie	prof. dr. P.A.M. Andriessen	2x	y	y			see handout
B A	**jr 3**	O_ORIBE TA	Orientatie science educatie	~~ir. J.G. Schoonhoven~~ ir. E.J.F. Scheringa	y					
B A	**jr 3**	AB_45024 0	Paleoklimatologie en meteorologie	dr. C.J. Beets	y	y	y	y		Atmospheric Science - Wallace, Hobbs
B A	**jr 3**	AB_45008 3	Petrologie van het systeem Aarde	prof. dr. G.R. Davies		y		y	exercises, presentations	
B A	**jr 3**	AB_45009 9	Sociale geografie I	dr. J.A. van der Schee	y	y	y	y	assignments	book: Human geography - Knox, Marston

B A	**jr 3**	AB_450081	Structurele geologie II	dr. L. Matenco						
B A	**jr 3**	AB_450142	Toegepaste geofysica	drs. M.M.A. Groen	y	y	y	y	exercises	book: An introduction to geophysical exploration - Kearey, Brooks, Hill
B A	**jr 3**	AB_450344	Veldwerkverslag geologie	dr. H. Stel	y				incl. AB_450079; contains thesis	
B A	**jr 3**	AB_450343	Veldwerkverslag geomorfologie	dr. C. Kasse	y				reports	
B A	**jr 3**	AB_470185	Wetenschapscommunicatie voor bèta-onderzoekers	F. Kupper	y	y	y	y	assignments	
B A	**jr 3 / geo**	AB_450026	Studie en loopbaan	dr. B.P. Zoetemeijer	y				reports	
B A	**jr 3 / geo**	AB_450097	Terrestrische milieus	~~dr. H. Renssen~~ dr. M.A. Prins						3 articles
B A	**jr 3 / geo**	AB_450090	Wetenschapsgeschiedenis voor Aard-, levens- en milieuwetenschappers	prof. dr. F. van Lunteren	y	y	y	y	assignments	reader
B A	**jr 3 / geo**	AB_450006	Wijsgerige vorming: aardwetenschappen, filosofie en ethiek	dr. H.W. de Regt						
B A	**geo**	AB_450034	Dateringsmethoden	prof. dr. H. Kars	y					
B A	**geo**	AB_450035	Geoarcheologisch veldwerk	dr. A.M.J. de Kraker						*see AB_450352*
B A	**geo**	AB_450104	Geoarcheologische prospectietechnieken	dr. S.K.A. Soetens	y	y	y	y	report	reader
B A	**geo**	L_BEBAARC207	Prehistorie van Nederland	prof. dr. N.G.A.M. Roymans	y	y				book: Nederland in de prehistorie - Kooijmans, van den Broeke, Fokkens, van Gijn
B A	**geo**	AB_450352	Uitwerking geoarcheologisch veldwerk	dr. A.M.J. de Kraker	y				reports	*information: 2008 - 2009*
B A	**geo**	AB_450157	Inleiding mineralogie	dr. W. van Westrenen						no course in 2011 - 2012

Bachelor course Aardwetenschappen / Master course Earth Sciences

B A / M E	**jr 3 / AE**	AB_450098	Bodem en milieu	dr. B.M. van Breukelen	y	y				Book Bodemkunde van NL - Locher, Bakker

Master courses Earth Sciences

M E	**AE**	AM_450404	Assessing the Landscape	drs. E. Koomen		y		y	practicals	8 articles
M E	**AE**	AM_450402	Decision Making Processes	drs. E. Vasileiadou	y	y		y		9 articles
M E	**AE**	AM_450401	Empirical Methods for Spatial Policy	prof. dr. P. Rietveld	y	y		y		book: Introduction to Econometrics - Stock, Watson

M E	**AE**	AM_468019	Energy System Transitions	dr. M. Hisschemoller						
M E	**AE**	E_STR_EEC	Environmental Economics	prof. dr. D.P. van Soest	y	y				
M E	**AE**	AM_450405	Exploring Earth Processes and Resources	dr. R.A.M. de Jeu	y	y	partly			
M E	**AE**	AM_450409	Geothermal Energy							not in 2011 - 2012
M E	**AE**	AM_450403	Imaging the Earth Surface	prof. dr. H.J.Scholten						
M E	**AE**	E_STR_IEE	International Environmental Problems	prof. dr. C.A.A.M. Withagen						
M E	**AE**	AM_450400	Microeconomic Foundation of Spatial Policy	dr. M.G. Lijesen	y	y	y	y	assign ments	4 articles and a book
M E	**AE**	AM_450408	Petroleum Systems	prof. dr. J. de Jager						
M E	**AE**	AM_450406	Project Environmental Impact Assessment	dr. M.A. van Drunen	y			1 rep ort	3 assess ments	1 article
M E	**AE**	E_STR_RUE	Regional and Urban Economics	prof. dr. H.L.F. de Groot	y	y	y			
M E	**AE**	AM_470502	Spatial ecology and global change	J. Rozema	y	y	y		essays, assign ments	book Biogeography - Cox and Moore
M E	**AE**	AM_468018	Sustainable Energy Analysis	dr. E. Papyrakis						
M E	**AE**	E_STR_TREC	Transport Economics	dr. A.J.H. Pels	y	y	y			
M E	**AE**	AM_468023	Water and Policy	prof. dr. J.C.J.H. Aerts		y				
M E	**AE / Pal / AEG**	AM_450188	Climate and Policy	prof. dr. J. Gupta	y	y		y	assign ments	
M E	**AE / Pal / AEG**	AM_450185	Modern Climate Systems	dr G.M. Ganssen		y			info exams comm.	
M E	**AE / Pal / AEG**	AM_450313	Modern Geo-ecosystems	dr. M.A. Prins	y	y			report s	13 articles
M E	**AE / Pal / AEG**	AM_450330	Sedimentary Environments and Climate Archives	dr. F.J.C. Peeters	y	y			info exami nation comm.	1 article
M E	**AE / Pal / Arch / AEG**	AM_450187	Man and Climate: From Hominids to Modern Civilisation	Erika Guttmann-Bond						
M E	**AE / SE**	AM_450170	Reflection Seismics	dr. L.C. Matenco						
M E	**AEG**	AM_468011	Sustainability and Growth	dr. A.J. Gilbert	y	y	y	y	review s	book: Principles of environmental sciences - Boersema, Reijnders
M E	**AEG**	AM_471014	Wetenschapsjournalistiek	F. Kupper					assign ments	
M E	**Arch**	AM_450289	Archaeometry III (Analytical Methods)	dr. P.Z. Vroon						
M E	**Arch**	AM_450291	Biological Archaeometry	L.M. Kootker MSc		y	y	y	report s	books: may contain traces of milk - LECHE, Biomolecular Archaeology - Brown-Brown, Archaelogy -

M E	**Arch**	AM_450294	Capita Selecta Geoarchaeology	prof. dr. H. Kars -> S. Kluiving	y				abstracts	3 articles
M E	**Arch**	AM_450191	International Masterclass Geoarchaeology	prof. dr. H. Kars					essays	
M E	**Arch**	L_BAMAARC009	Perspectives on Ancient Landscapes	prof. dr. J.C.A. Kolen	y				no essays yet	9 articles
M E	**Arch / SE**	AM_450172	Advanced Inorganic Geochemistry	prof. dr. G.R. Davies	y				peer reviews, presentations	
M E	**Pal**	AB_450168	Sociale geografie II	dr. J.A. van der Schee		y	y	y	assignment	books: The ethnic cleansing of Palestine - Pilger; Denken over regio's - de Pater; Het geografische huis - de Pater , van der Wusten; Urban social geography - Knox, Pinch; Geography - Haggett
M E	**Pal / AEG**	AM_450004	Climate Modelling	dr. H. Renssen	y	y	y	y	pres: only grades	y
M E	**Pal / AEG**	AM_450145	Environmental Remote Sensing	dr. R.A.M. de Jeu	y	y	y	y		
M E	**Pal / AEG**	AM_450332	Global Biogeochemical Cycles	dr. J. van Huissteden					essays	
M E	**Pal / AEG**	AM_450331	High Resolution Archives	dr. H.B. Vonhof	y	y	y	y		
M E	**Pal / AEG**	AM_450266	Practical: Palaeoclimate Change and Environmental Impacts	dr. M.A. Prins				y	reports	Book: Earth's climate, Ruddiman; 6 articles
M E	**Pal / AEG**	AM_450354	Scotland Excursion	dr. S.J.P. Bohncke	y					
M E	**Pal / AEG**	AM_450058	Sediment Petrography of Heavy Minerals	dr. C. Kasse	y				paper	Heavy minerals in colour - Mange, Maurer
M E	**Pal / AEG**	AM_1015	Sustainable Land Management	drs. W.A.M. Tuijp		y		y	papers	book: Where the land is greener - WOCAT
M E	**Pal / AEG / SE**	AM_450146	From Source to Sink: Chemical and Physical Cycles	dr. M. ter Voorde	y	y			exercises	book: Tectonic Geomorphology
M E	**Pal / Arch / AEG / SE**	AM_450292	Historical Geography	dr. A.M.J. de Kraker	y			paper s		
M E	**Pal / Arch / AEG / SE**	AM_450054	Palaeo-ecology/Palynology	dr. S.J.P. Bohncke		y	y		info exams comm.	
M E	**SE**	AM_450171	Advanced Geochronology	dr. J.R. Wijbrans	y				posters/essays	2 articles
M E	**SE**	AM_450175	Building Tectonic Models	dr. W.W.W. Beekman						
M E	**SE**	AM_450144	Capita Selecta Structural Geology and Tectonics	dr. E. Willingshofer						
M E	**SE**	AM_450169	Diagenesis of Sedimentary Rocks	via Hubert Vonhof	y	y	y	y		book: Diagenesis - McIlreath, Morrow
M E	**SE**	AM_450229	IntroductionField	dr. L.C. Matenco						

M E	**SE**	AM_450180	Low Temperature Deformations of Rocks and Regions	dr. G.V .Bertotti						
M E	**SE**	AM_450189	Magmatic Processes	prof. dr. G.R. Davies		y		y		
M E	**SE**	AM_450225	Mantle Properties in Lithosphere Development	prof. dr. G.R. Davies	y	y	y	y	exercises	1 article
M E	**SE**	AM_450176	Metamorphism and P-T Evolution	dr. F.M. Brouwer		y	y	y	paper	books: Petrogenesis of metamorphic rocks - Bucher, Frey; Principles of igneous and metamorphic petrology - Winter
M E	**SE**	AM_450158	Microstructures in Tectonites	dr. H. Stel	y	y				
M E	**SE**	AM_450190	Orogenesis	dr. J.R. Wijbrans	y	x	x	x	assignments; info exams comm.	Books: Global tectonics - Kearey, Klepeis, Vine; Geodynamics of the lithosphere - Stüwe; The solid earth - Fowler
M E	**SE**	AM_450179	Petroleum Systems and Regional Geology	prof. dr. J. de Jager						
M E	**SE**	AM_450273	Planetary Science	prof. dr. G.R. Davies		y		y	posters, presentations, info exams comm.	
M E	**SE**	AM_450277	Practical Subsurface Evaluation Workshop	prof. dr. J. de Jager						no course in 2011 - 2012
M E	**SE**	AM_450164	Precambrian Geology	dr. J.R. Wijbrans	y				posters	
M E	**SE**	AM_450154	Sedimentary Basins	dr. G.V .Bertotti	introduction					
M E	**SE**	AM_450061	Volcanism	dr. P.Z. Vroon						

Master courses Hydrology

M Hyd	**AEG**	AM_450003	Catchment Response Analysis	dr.. M.J. Waterloo		y	y	y		
M Hyd	**AEG**	AM_450126	Field Course Netherlands (Measurements Techniques)	dr. J. Groen						
M Hyd		AM_450133	Contaminant Hydrogeology	dr. B.M. van Breukelen	y	y			assignments	10 articles
M Hyd		AM_1013	Field Course Hydrology Portugal	dr. M.J. Waterloo		y	y	y		
M Hyd		AM_450132	Groundwater Microbiology and Geochemistry (Geomicrobiology)	dr. W.F.M. Röling					self-study modules	book: Biology of microorganisms - Brock; Environmental Microbe-metal interactions, chapter 1 (Lovley)
M Hyd		AM_450148	Isotope Hydrology	dr. H.J. van Meerveld	y	y	y	y		
M Hyd		AM_450131	Transport Processes in Groundwater	dr. H. Kooi						book: Hydrogeology - Domenico, Schwartz

Master courses Hydrology / Earth Sciences

M Hyd / M E	**AE / AEG**	AM_450137	Aquatic Ecology	dr. ir. J.F. Vermaat	y	y	y			Ecology of aquatic systems; reader
M Hyd / M E	**AE / AEG / SE**	AM_450014	Ecohydrology	dr. M.J. Waterloo	y	y	y	y		
M Hyd / M E	**AEG**	AM_450009	Groundwater Hydraulics	dr. H. Kooi						book: Hydrogeology - Domenico, Schwartz
M Hyd / M E	**AEG**	AM_450052	Hydrochemistry	dr. B.M. van Breukelen	y	y	y		exerc. Manual	Book Geochemistry - Appelo, Postma
M Hyd / M E	**AEG**	AM_1012	Hydrological Systems and Water Management	prof. dr. P.J. Stuijfzand		y	y	y		book: Hydrochemistry and hydrology of… - Stuyfzand; 2 articles
M Hyd / M E	**Arch / AEG**	AM_450227	Applied Geographical Information Systems	dr. R.A.M. de Jeu	y				paper, abstract	
M Hyd / M E	**Arch / AEG**	AM_450226	Basics in GIS	dr. R.A.M. de Jeu	y	y			assignments	
M Hyd / M E	**Pal / SE**	AM_450021	Unsaturated Zone and Near Surface Hydrological Processes	dr. H.J. van Meerveld		y	y	y (oral pres. too)	practical	

Appendix 5: Quantitative data regarding the programmes

Data on intake, transfers and graduates

Bachelor's programme

cohort 2006 /2007	Number of enrolments: 28 Re-inscription 2nd year: 26 (93%) Dropouts 1st year: 2 (7%) Dropouts total 9 (32%) Diploma efficiency : 32% within 3 years, 43% within 4 years, 64% within 5 years
cohort 2007 /2008	Number of enrolments: 45 Re-inscription 2nd year: 41 (91%) Dropouts 1st year: 4 (9%) Diploma efficiency : 20% within 3 years, 36% within 4 years
cohort 2008 /2009	Number of enrolments: 41 Re-inscription 2nd year: 41 (100%) Dropouts 1st year: 0 (0%) Diploma efficiency: 23% within 3 years
cohort 2009 /2010	Number of enrolments: 57 Re-inscription 2nd year: 49 (86%) Dropouts 1st year: 8 (14%)
cohort 2010 /2011	Number of enrolments: 67 Re-inscription 2nd year: 55 (82%) Dropouts 1st year: 12 (18%)1
cohort 2011 /2012	Number of enrolments: 65 Dropouts 1st year: 5 (8%, official number per April 2012)

Master's programme in Earth Sciences

Cohort	VU	Dutch universities	HBO (Pre-masters)	International	Female (%)	Total (*MIVU*)	Dropouts (%)	Graduates (/ yr)
2005	19	2	1	5	41%	27	25%	7
2006	12	2	0	4	72%	18	29%	17
2007	8	3	0	12	39%	23	23%	12
2008	16	0	0	6	41%	22	8%	26
2009	28	1	1	4	35%	34	11%	12
2010	19	4	0	2	56%	25	0%	20
2011	29	1	0	2	28%	32		
Average per year	19	2	0	5	45%	26	16%	16

Hydrology master's programme

Cohort year	Size	2-year graduation (%)	3-year graduation (%)	4-year graduation (%)	Still active (%)
2004	7	14	71	100	0
2005	13	23	46	69	15
2006	9	11	56	56	11
2007	12	17	25		58
2008	11	0			82
2009	28	7			89

Teacher-student ratio achieved

Bachelor's programme

Total number of students in 2011-2012 amounts 194. The total amount of FTE of all lecturers in the programme is 40; making a student/staff ratio of 5. The lecturing FTE's involved in the programme amounts 10, resulting in a student/staff ration of 20.

Master's programme in Earth Sciences

According to the NVAO definition of Student / Staff ratio in WO, which is the ratio between the total number of enrolled full-time students and the total number of FTEs of academic staff training in the most recent academic year, this ratio is 1:6; 93 students and 56

fte's scientific staff involved (see appendix I). One has to consider that most staff have a small contribution to training at MSc level, because of research activities, and also because of lecturing at the BSc level.

Hydrology's master programme

The NVAO definition of the student/lecturer ratio is the number of students in the programme divided by the total FTE of the scientific teaching staff and these ratios are used at face value in Table 6. It should be noted, however, that for almost all lecturers teaching is only part of their task (40-80%) and that they may also teach in various other BSc and MSc programmes. On the other hand, contributions of guest lecturers, PhD students and supervisors of external internship placements who are not employed by the VUA, are not counted. A more realistic ratio, only counting FTE units spent on teaching in the Master's programme, would approach a value of 18 for the year 2011 -2012.

Average amount of face-to-face instruction per stage of the study programme

Bachelor's programme

Year 1: 740 hours are under supervision of a lecturer, e.g. 18.5 h/week
Year 2: 700 hours are under supervision of a lecturer, e.g. 17.5h/week
Year 3: 380 hours under supervision; e.g. 9.5 h/week

Master's programme in Earth Sciences

Phase/specialised course	Contact hours (average/week)
Lecturers present	
Lectures	8.7
Practicals; laboratory work, Computer modelling	4.2
Project/Internships	0.6
General guidance related to MSc programme	0.3
Exams	1.1
Excursions, fieldwork	1.9
Total	**16.8**
No lecturers present	
Self-study	8.0
Internships	3.6
Master projects	14.2
Total	**25.8**
Overall Total	**42.6**

Hydrology's master's programme

Course type (period)	Contact hours (per week)	Lecturer/student ratio	No. of Lecturers
Classroom lectures, computer and laboratory workshops	12-16	1:8 – 1:25	1-2
Field courses (ten weeks at end of second semester)	40-55	1:3 – 1:10	2-5
Research project (fourth semester)	2-6	2:1	2

Appendix 6: Programme of the site visit

Dinsdag 18 september VU Amsterdam

09.00 09.05 ***Welcome***
dr. N. (Nellie) Harms (Director of Education),

09.05 12.00 ***Deliberations of the panel***, s***tudy of documents presented*** (incl lunch)

12.00 13.00 ***Management***
prof. dr. B. (Bauke) Oudega (Dean),
dr. N. (Nellie) Harms (Director of Education),
prof. dr. H. (Hans) Renssen (Programme Director BSc AW),
prof. dr. J.J.G. (John) Reijmer (Programme Director MSc ES),
prof. dr. L.A. (Sampurno) Bruijnzeel (Programme Director MSc Hydro)

13.00 13.45 ***Students Bachelor AW***
N. (Nadav) Agmon (second year)
M. (Max) Holthuis (second year)
L. (Lisette) Beets (second year)
Track I, Solid Earth:
T. (Tiemen) Gordijn (third year)
S. (Suzette) Timmerman (fourth year)
E. (Evy) Kalker (fourth year)
Track II, Earth Surface:
M. (Manouk) Los (third year)
S. (Sigrid) van Grevenbroek (third year)
C. (Colin) Straathof (third year)
M. (Maartje) Korver (fourth year)

13.45 14.30 ***Teachers Bachelor AW***
dr. F.M. (Fraukje) Brouwer (cluster Deep Earth)
dr. C. (Kees) Kasse (cluster Earth and Climate)
dr. C.J. (Kay) Beets (cluster Earth and Climate)
dr. J. (Ko) van Huissteden (cluster Earth and Climate, *Statistics*)
dr. B. (Bernd) Andeweg (cluster Earth and Natural Resources)
dr. B.P. (Reini) Zoetemeijer (cluster Earth and Natural Resources, *Physics*)
dr. R.T. (Ronald) van Balen (cluster Earth and Climate, *Surface*)
dr. W. (Wim) van Westrenen (cluster Deep Earth),
prof. dr. J.J.G. (John) Reijmer (cluster Earth and Natural Resources)

14.30 15.00 ***Break***

15.00 15.45 ***Students Master ES and Master Hydro***
T.I.E. (Ted) Veldkamp BSc (MSc ES, specialisation Earth Sciences and

Economics)
M. (Mieke) Huisman BSc (MSc ES, specialisation Applied Environmental Geosciences)
B. (Bertram) Uunk BSc (MSc ES, specialisation Solid Earth)
F. (Fienke) Nanne BSc (MSc ES, specialisation Solid Earth)
L.G. (Laura) van der Sluis BSc (MSc ES, specialisation Geoarchaeology)
L. (Laura) del Val Alonso BSc (second year, MSc Hydrology)
S. (Sonia) Borja Quintero BSc (second year, MSc Hydrology)
R. (Robin) van Schalie BSc (first year, MSc Hydrology)
S. (Sietse) Bos BSc (first year, MSc Hydrology)

15.45 16.30 ***Teachers Master ES and Master Hydro***

dr. M.J. (Maarten) Waterloo (MSc Hydrology),
dr. H. (Henk) Kooi (MSc Hydrology),
dr. R.A.M. (Richard) de Jeu (MSc Hydrology),
dr. E. (Eric) Koomen (MSc ES, specialisation Earth Sciences and Economics)
dr W. (Wim) van Westrenen (MSc ES, specialisation Solid Earth),
prof. dr. J.J.G. (John) Reijmer (MSc ES, specialisation Solid Earth),
dr. S.J.P. (Sjoerd) Bohncke (MSc ES, specialisation Paleoclimatology and specialisation Applied Environmental Geosciences)
dr. C. (Kees) Kasse (MSc ES, specialisation Applied Environmental Geosciences),
prof. dr. H. (Henk) Kars (MSc ES, specialisation Geoarchaeology)

16.30 16.45 ***Break***

16.45 17.15 ***Alumni***

M. (Mahtab) Mozafari MSc (MSc ES, specialisation Solid Earth)
M. (Maarten) Kuiper MSc (MSc ES, specialisation Hydrology)
B. (Beatriz) de la Loma Gonzalez MSc (MSc ES, specialisation Hydrology)
M. (Maartje) Faasse MSc (MSc ES, specialisation Hydrology)
A. (Annelies) Koopman MSc (MSc ES, specialisation Geoarchaeology)
A. (Ananda) Floris MSc (MSc ES, specialisation Solid Earth)
M. (Marlies) Janssens MSc (MSc ES, specialisation Applied Environmental Geosciences)

Appendix 7: Theses and documents studied by the committee

Prior to the site visit, the committee studied the theses of the students with the following student numbers:

Bachelor's programme

Graduates 2009- 2010 Student number	Graduates 2010- 2011 Student number
1274392	1561286
1330179	1615769
1476203	1713426
1487698	1725440
1513389	1777173
1536974	1865161
1663240	
1707795	
1715127	

Master's in Earth Sciences	*Hydrology*
1330063	1397656
1473948	1766643
1718738	1840789
1719157	1826514
1723790	1473913
1397567	1578170
1473891	
1548026	
1689665	
1752111	
1362836	

During the site visit, the committee studied, among other things, the following documents (partly as hard copies, partly via the institute's electronic learning environment):

Content Ordner Rules, Regulations and Guidelines

1.

Bestuursreglement VU (only in Dutch)

Studentenstatuut 2012-2013 (only in Dutch)

2.

Academic and Examination Regulations (AER) Master's degree programmes (only in English)

Onderwijs- en Examenregeling (OER) Bacheloropleidingen FALW (only in Dutch)

Rules and Guidelines of the Examination Board/Regels en Richtlijnen van de Examencommissie

Formulier verzoek aan Examencommissie/Form Request Examination Board

Beheerregeling bij het afnemen van tentamens in gemeenschappelijke tentamenruimtes (only in Dutch)

3.

Student Placement (Internship) and Research Project Regulations 2012

Toetsen en beoordelen (only in Dutch)

Werkwijze evaluatie toetsing van de Examencommissie (only in Dutch)

4.

Regulations for Safety in Fieldwork/ Voorschriften Veiligheid rond Veldwerk

Guidelines for Safety in Fieldwork/ Aandachtspunten Veiligheid rond Veldwerk

Fieldwork Declaration (only in English)

Veiligheid bij practica (only in Dutch)

Veiligheids- en milieuvoorschriften voor de practica (only in Dutch)

Vaccinaties (only in Dutch)

5.

Richtlijn Studiebegeleiding FALW (only in Dutch)

Regeling Bindend Studieadvies FALW (only in Dutch)

Procedure bindend studieadvies (BSA) in geval van persoonlijke omstandigheden (only in Dutch)

6.

Regulations on grants for Fieldwork and Field Trips/ Subsidieregeling excursies en veldwerk

Financiële Ondersteuning Studenten en Faciliteitenregeling (only in Dutch)

7.

Regulation Knowledge, Intellectual Property and the Participation of VU University Amsterdam (VU)

and VUmc/ Regeling Kennis, Intellectueel Eigendom en Participatie VU en VUmc

Code of conduct for computer and network use/ Gedragscode computer- en netwerkgebruik

8.

Opleidingsbeleid FALW (only in Dutch)

Richtlijn benoeming en bevordering UD's en UHD's (only in Dutch)

Notitie hooglerarenbeleid (only in Dutch)

9.

Evaluatieplan Bacheloropleidingen (only in Dutch)

Map Information on study and study guidance (mainly in Dutch)

Map minutes and reports Examination Committee, Education Committee

1. Notulen examencommissie Aardwetenschappen 2011, 2012
2. Jaarverslagen examencommissie Aardwetenschappen 2009-2010/ 2010-2011
3. Jaarverslagen tentamencommissie Aardwetenschappen 2010-2011/2011-2012
   Werkwijze evaluatie toetsing binnen de FALW opleidingen
4. Notulen opleidingscommissies BSc Aardwetenschappen en MSc Earth Sciences
   2011 (BSc en MSc samen in 1 commissie)
   2012 (BSc en MSc aparte commissies)

Map Course evaluations

1. Cursusevaluaties BSc Aardwetenschappen 2010-2011/2011-2012

Algemene vaardigheden 2010-2011
Bodem en Milieu 2010-2011 & 2011-2012
Bodemkunde 2010-2011
Computermodelleren 2011-2012
Digitale ruimtelijke data 2010-2011 & 2011-2012
Fysica voor aardwetenschappers 2010-2011 & 2011-2012
Geochemie voor aardwetenschappers 2010-2011
Geomorfologie A + GIS 2011-2012
Geomorfologie inclusief veldpracticum 2010-2011
Global Change 2010-2011
Hydrologie van NL 2010-2011
Inleiding anorganische geochemie 2010-2011
Inleiding Hydrologie 2011-2012
Inleiding in de biogeologie 2011-2012
Isotopengeochemie 2011-2012
Kaart- en profielconstructies 2011-2012
Kwartairgeologie / geologische landschappen van NL 2010-2011
Mineralogie 2011-2012
Paleoklimatologie en meteorologie 2011-2012
Petrologie van het systeem aarde 2011-2012
Prehistorie van Nederland 2011-2012
Ruimtelijke beeldvorming 2010-2011
Sedimentaire systemen in ruimte en tijd 2010-2011 & 2011-2012
Sedimentologie en stratigrafie 2010-2011
Sociale geografie 1 2010-2011
Statistiek en data-analyse 2010-2011
Structurele geologie I inclusief veldpracticum 2011-2012
Studie en loopbaan aardwetenschappen 2011-2012
Systeem aarde 2010-2011
Terrestrische milieus 2010-2011

Toegepaste geofysica 2010-2011 & 2011-2012
Veldwerk 1e jaar Fuente Alamo 2010-2011 & 2011-2012
Veldwerk Brabant 2010-2011
Veldwerk geologie 2010-2011
Veldwerk Jura morfologie 2011-2012
Veldwerkverslag aardwetenschappen 2011-212
Veldwerkverslag geomorfologie 2010-2011
Wetenschapsgeschiedenis 2010-2011
Wijsgerige vorming 2011-2012
Wis- en natuurkunde 2010-2011 & 2011-2012
Wiskunde en computergebruik 2011-2012

2. Cursusevaluaties MSc Earth Sciences 2010-2011/2011-2012

Assessing the landscape 2010-2011
Aquatic Ecology 2010-2011 & 2011-2012
Basics in GIS 2011-2012
Bodem en milieu 2011-2012
Building tectonic models 2011-2012
Capita selecta geoarchaeology 2011-2012
Catchment respons analysis 2011-2012
Climate and policy 2011-2012
Climate modelling 2010-2011
Decision making processes 2010-2011 & 2011-2012
Ecohydrology 2011-2012
Emperical methods of spatial policy 2010-2011
Environmental remote sensing 2011-2012
Exploring earth processes and resources 2010-2011 & 2011-2012
From source to sink 2011-2012
Geothermal energy 2010-2011
Global biogeochemical cycles 2011-2012
Groundwater hydraulics 2011-2012
High resolution archives 2010-2011
Historical geography 2011-2012
Hydrological systems and water management 2011-2012
Imaging the earth surface 2011-2012
Introduction field excursion 2011-2012
Man and climate 2011-2012
Mantle properties in lithosphere development 2010-2011 & 2011-2012
Metamorphism and P-T evolution 2011-2012
Microeconomic foundation of spatial policy 2010-2011 & 2011-2012
Modern climate systems 2011-2012
Modern geo-ecosystems 2011-2012
Orogenesis 2011-2012
Palaeoclimate change & environmental impact 2011-2012
Palaeo-ecology/palynology 2011-2012
Petroleum systems and regional geology 2010-2011
Planetary sciences 2011-2012
Precambrian geology 2011-2012
Project environmental impact assessment 2010-2011
Refection seismics 2011-2012

Sedimentary basins 2010-2011
Sedimentary environments and climate archives 2010-2011 & 2011-2012
Sediment petrography of heavy minerals 2011-2012
Sustainability and growth 2010-2011 & 2011-2012
Sustainable energy analysis 2010-2011
Sustainable land management 2011-2012
Unsaturated zone 2011-2012
Water and policy 2011-2012
Wetenschapsjournalistiek 2011-2012

3. Cursusevaluaties MSc Hydrology 2010-2011/2011-2012

Applied geographical information systems 2011-2012
Aquatic ecology 2010-2011 & 2011-2012
Basics in GIS 2011-2012
Catchment response analysis 2011-2012
Ecohydrology 2011-2012
Environmental remote sensing 2011-2012
Field course hydrology 2011-2012
Groundwater flow modelling 2010-2011
Groundwater Hydraulics 2011-2012
Hydrological systems and water management 2011-2012
Isotope hydrology 2011-2012
Transport processes in groundwater 2011-2012
Unsaturated zone 2011-2012

Map Evaluations

1. Eindvragenlijst bachelorfase Aardwetenschappen 2010-2011
2. Curriculum evaluation MSc programmes FALW, MSc Earth Sciences & MSc Hydrology
3. Nationale Studenten Enquête 2011
4. WO-Monitor VU 2011

Appendix 8: Declarations of independence

nvao
nederlands-vlaamse accreditatieorganisatie

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: PROF. M.A. HERBER

HOME ADDRESS: VINDUEWEG 10, 9751 HR HAREN

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

SEE ATTACHMENT

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

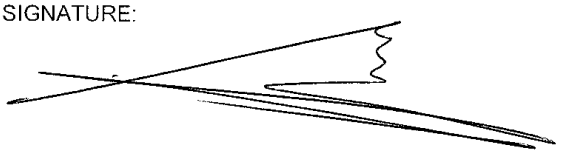
SEE ATTACHMENT

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS; CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO; HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: HAREN DATE: 25/6/12

SIGNATURE:



nvao
nederlands - vlaamse accreditatieorganisatie

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: MARTIN LANDRØ

HOME ADDRESS: K.O. THORNÆS V.1, 7033 TRONDHEIM, NORWAY

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

SEE ATTACHMENT

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

SEE ATTACHMENT

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS; CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO; HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: WAGENINGEN DATE: 25 June 2012

SIGNATURE: Martin Landrø

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nederlands - vlaamse accreditatieorganisatie

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Jan W Hopmans

HOME ADDRESS: 1508 Eligio Lane
DAVIS CA 95618 USA

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

SEE ATTACHMENT

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

SEE ATTACHMENT

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

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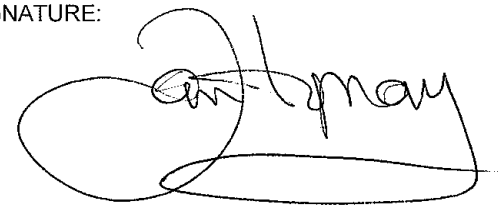
PLACE: Wageningen DATE: June 25 2012

SIGNATURE:



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nederlands-vlaamse accreditatieorganisatie

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Professor Desmond E. Walling

HOME ADDRESS: Orchard Close, Lynch Road, Thorverton, EXETER, EX5 5PS, Devon, UK

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

Earth Sciences

SEE ATTACHMENT

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

SEE ATTACHMENT

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS; CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO; HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Wageningen. DATE: 25.6.12

SIGNATURE: D.E. Walling

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DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: Renate Prenen

HOME ADDRESS: Simon Stevinweg 21 Bussum

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / SECRETARY:

SEE ATTACHMENT

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

SEE ATTACHMENT

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS; CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO; HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Delft DATE: 17-09-'12

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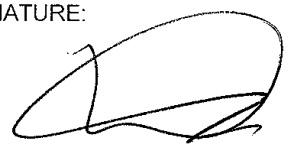

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DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: M.M. Cazemier

HOME ADDRESS: Haarweg 117, 6709 PX, Wageningen

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN EXPERT / ~~SECRETARY:~~

SEE ATTACHMENT

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

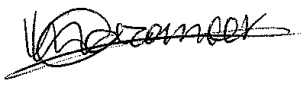
SEE ATTACHMENT

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS; CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO; HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Wageningen DATE: 13-09-2017

SIGNATURE:



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nederlands-vlaamse accreditatieorganisatie

DECLARATION OF INDEPENDENCE AND CONFIDENTIALITY

TO BE SUBMITTED PRIOR TO THE ASSESSMENT OF THE PROGRAMME

THE UNDERSIGNED

NAME: W.v. Gastel

HOME ADDRESS: Riverforel 35 2318 MG Leiden

HAS BEEN ASKED TO ASSESS THE FOLLOWING PROGRAMME AS AN ~~EXPERT~~ / SECRETARY:

SEE ATTACHMENT

APPLICATION SUBMITTED BY THE FOLLOWING INSTITUTION:

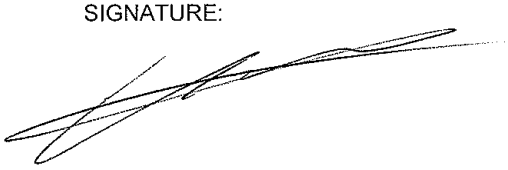
SEE ATTACHMENT

HEREBY CERTIFIES TO NOT MAINTAINING ANY (FAMILY) CONNECTIONS OR TIES OF A PERSONAL NATURE OR AS A RESEARCHER / TEACHER, PROFESSIONAL OR CONSULTANT WITH THE ABOVE INSTITUTION, WHICH COULD AFFECT A FULLY INDEPENDENT JUDGEMENT REGARDING THE QUALITY OF THE PROGRAMME IN EITHER A POSITIVE OR A NEGATIVE SENSE;

HEREBY CERTIFIES TO NOT HAVING MAINTAINED SUCH CONNECTIONS OR TIES WITH THE INSTITUTION DURING THE PAST FIVE YEARS; CERTIFIES TO OBSERVING STRICT CONFIDENTIALITY WITH REGARD TO ALL THAT HAS COME AND WILL COME TO HIS/HER NOTICE IN CONNECTION WITH THE ASSESSMENT, INSOFAR AS SUCH CONFIDENTIALITY CAN REASONABLY BE CLAIMED BY THE PROGRAMME, THE INSTITUTION OR NVAO; HEREBY CERTIFIES TO BEING ACQUAINTED WITH THE NVAO CODE OF CONDUCT.

PLACE: Wageningen DATE: 25.06.2012

SIGNATURE:



Attachment composition committee Earth Sciences

	Wagening University	Utrecht University	University of Amsterdam	VU Amsterdam	TU Delft
Visit	**25-26 June 2012**	**27-28 June 2012**	**29 June 2012**	**18-19 September 2012**	**16-17 September2012**
Chair	Prof. M.A. Herber	Prof. M.A. Herber	Prof. M.A. Herber	Prof. M.A. Herber	Prof. M.A. Herber
Member	Prof. M. Landrø	Prof. M. Landrø	Prof. M. Landrø	Prof. M. Landrø	Prof. M. Landrø
Member	Prof. J.W. Hopmans	Prof. J.W. Hopmans	Prof. J.W. Hopmans	Prof. J.W. Hopmans	Prof. J.W. Hopmans
Member	Em. Prof D.E. Walling	Em. Prof D.E. Walling	Em. Prof D.E. Walling	Em. Prof D.E. Walling	Em. Prof D.E. Walling
Member	Dr. M.A. Ossevoort	Dr. M.A. Ossevoort	Dr. M.A. Ossevoort	Drs. R.L. Prenen	Drs. R.L. Prenen
Student	E. Rost	E. Rost	M. Weekenstroo	M. Cazemier	M. Cazemier
Secretary	dr. W. van Gastel	dr. W. van Gastel	dr. W. van Gastel	dr. W. van Gastel	dr. W. van Gastel

Institution:	**Programme (CROHO)**	**Mode of study**	**Final date accreditation**
Technische Universiteit Delft	B Technische Aardwetenschappen (56959)	Full time	31-12-2013
	M Applied Earth Sciences (60360)	Full time	31-12-2013
Universiteit Utrecht	B Aardwetenschappen (56986)	Full time	31-12-2013
	M Earth Sciences (66986)	Full time	31-12-2013
Universiteit van Amsterdam	M Earth Sciences (66986)	Full time, part time	31-12-2013
Vrije Universiteit Amsterdam	B Aardwetenschappen (56986)	Full time	31-12-2013
	M Earth Sciences (66986)	Full time	31-12-2013
	M Hydrology (60807)	Full time	31-12-2013
Wageningen Universiteit	B Bodem, water, atmosfeer (56968)	Full time	31-12-2013
	M Earth and Environment	Full time	31-12-2013