

Norwegian University of Life Sciences
Faculty of Environmental Science and Technology
Department of Environmental Sciences

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NMBU report

External evaluation of the BSc programme MIRE offered at the University of Bergen

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Preface

The request to carry out an external evaluation of the MIRE program came at a very suitable moment for me. I had moved to Ås in the summer of 2014 for the position of head of the Department of Environmental Sciences (IMV), which has responsibility for a similar Bachelor program called MINA (Miljø og Naturressurser, Environment and Natural Resources). Back in The Netherlands, I had responsibility for the BSc and MSc program in Earth Sciences and Economics. I guided the BSc program through its first full-scale and legally required external evaluation in 2012. During this first year in Ås, I became acquainted with the specificities of the Norwegian University system and sometimes had to adjust my, often implicit, expectations and value judgments drawn from VU University in Amsterdam and the International Institute for Environmental, Hydrological and Hydraulic Engineering in Delft. Thus, in the autumn of 2015 I was actually curious how other Norwegian Universities would organize their curriculum, work out student uptake, and struggle with all the other organizational details that together form an academic BSc program.

I have tried to separate analysis from advice but can only stress that this is a report from one single person. I cannot pretend to be fully objective or impartial but have tried to be clear and follow the simplicity of 'if-then-else' logics. Since this a single author report, I chose to write it in the first person rather than use a more formal and convolute third person.

I met a very strong engagement with MIRE, especially among the students I talked to, and among the responsible administrative staff. I sincerely hope this report will contribute to an improvement of the MIRE curriculum. I thank Magnus Svendsen Nerheim for his excellent support and all who talked with me during the site visit (see annex 2) for their willingness to be open and clear. Sincere thanks are due to Mona Henriksen, chair of the education board (undervisningsutvalg) at IMV, for critically reviewing this report.

Ås, 23 november (first draft) and 15 december 2015

Jan Vermaat

Introduction

The Department of Biology (IB) of the University of Bergen appointed me as external sensor of the crossdisciplinary bachelorprogram Miljø og Ressursfag (Environment and Resources) by formal letter received on October 30. Terms of references were sent to me earlier by electronic mail. These are available in Norwegian only (Annex 1). In short, these involved 10 successive detailed queries from the program board on issues where the sensor should express his views on, and two, more 'grand' questions formulated by the head of the program board, Inga Kjersti Sjøtun, sent to me separately. These latter two are formulated as follows¹:

- 1) Is this programme organised in an optimal and most appropriate way given the current boundary conditions (Er studiet organisert på den beste og mest hensiktsmessige måten ut fra de rammebetingelsene vi har nå)?
- 2) What external boundary conditions shall we have to face and try to influence to improve the study in terms of quality and expediency (Hvilke rammebetingelser bør vi arbeide med i framtiden slik at studiet blir organisert på en bedre og mer hensiktsmessig måte)?

In my view, these two main questions would have benefitted from a round of refinement (optimal and appropriate for whom? External outside which boundary?). The same holds for some of the 10 specific queries, but here in my view is also an issue of balance and strong interdependence. I discussed this with Magnus Nerheim and Kjersti Sjøtun and received the answer that I should focus on the two grand questions specified above. The first question actually reads like a rhetoric question waiting for the answer 'no'. I interpreted this to mean that at least some of the parties involved, be it students, teachers, study administration or university leadership, experience imperfection in course subjects, curricular timing, coherence of content or portfolio, or something else inside the program offered. For Question 2 I then interpreted 'the outside world' as everything outside the formal MIRE curriculum, so including the framework given by the Institute of Biology as its formal hosting institute. I then decided to follow the advice of Nerheim and Sjøtun, but write out a simplified analytical framework that could guide me in my evaluation and further discuss the issue of unclarity in the terms of references during the site visit. A one-day site visit plus a part time study running over 1 month will not allow me to answer all 10 specific questions, so I decided to focus on some and ignore others. The framework is nothing more than a systematic clustering of the questions. It is worked out further in the next section 'Approach'.

During my preparation for the site visit I was uncertain as to whether the situation should be considered as a major and 'acute' problem. The student representation ('fagutvalg') evaluation report of 2013 writes 'uholdbar' and 'ingen sammenheng', which feels rather serious but on face value may also have been strategically heavy rhetoric. However, during the site visit Øyvind Fiksen expressed the opinion that this would be the moment to either fully lay down the program or make significant improvements². This convinced me that both the students and the management of the Institute of Biology recognize serious problems in the implementation of the curriculum of MIRE, and in its boundary conditions. My analytical framework assists me in revealing what the real problem(s) are, but

¹ the translations are mine and indicate that I am actually not so sure how to interpret them, also after the site visit

² 'enten legges ned eller styrkes inkl. Master' is in my notes

it does not spell out immediate solutions. A view on a useful solution of a problem depends very much on the perspective. An important point here is whether a problem owner (he or she who suffers from it) also has the means to become problem solver. For this purpose I have tried to sort out different, contrasting scenarios.

In resume, this report first outlines my approach to frame and balance the different queries posed to me. It then identifies the main problems and their actual owners. This allows the advice to focus on what different measures will mean for different parties involved, and I try to grasp possible future designs of MIRE in three contrasting scenarios.

Table 1. Matrix of review framework questions versus 10 queries

Aspect of the program	Detailed questions addressed and notes	Numbered queries from terms of reference (Annex 1)
Educational – learning objectives	Are ‘learning outcomes’ and ‘competences to be achieved’ specified? Do they form a coherent system and match with the overall study objectives? Are they met by the individual courses offered?	1, 2
Educational – working formats	Do the different formats chosen in the courses match with the learning objectives? Is the hierarchy included from ‘to know’, via ‘to be able to apply’ to ‘independent judgment and reflection’ and reflected in the forms of examination? Discussed mainly with students and teachers.	1, 2, 3
Educational – curriculum doable?	Does the time table and distribution of the courses allow the students to complete the program within the norm of 3 years? Does it ensure the advertised freedom of choice (80 ects)? Discussed with program administration and students	3, 4
Educational – comparison with similar programs	How does the program compare with MINA (NMBU) and ES&E (VU Amsterdam)? Only carried out a limited comparison.	8
Student recruitment	Is an acceptable number of students recruited from secondary school?	4, 10
Student performance and drop outs	How are student progress statistics? How many drop outs occur in which phase of the curriculum?	4, 10
Student job perspective	Is the job perspective clarified fairly for new recruits and does it get sufficient attention during the 3 years?	9
Institution – staff engagement	Is the teaching staff specifically hired for, or personally engaged with this cross-disciplinary program?	None
Institution – organization and reflection on student feed back	How is the student feedback organized and how is it included in the evaluation and organisation of the program?	6, 7
Institution – formal embedding of the program	How is the program formally embedded? Does this ensure an optimal organization of the curriculum, so that it can meet its learning objectives?	7

Approach

Firstly and most importantly, the main sources of information are the formal course documents and study statistics offered to me by the IB and the both formal and informal discussions with staff and students during the site visit of 2 November 2015. Annex 2 stipulates the program of this site visit. This is mainly qualitative information and therefore my interpretation may have been subject to more bias than I am aware of or used to in my day-to-day scientific practice using 'ordinary' quantitative data. I hope I have refrained from being too imaginative or biased by what I think³ should be a cross-disciplinary academic program.

Secondly, since I decided to reorganize the two lists of queries (10 specific, 2 grand) into my own analytical framework, I will specify how these 10 plus 2 questions are reflected in this framework (Table 1). This forms the bulk of this section. The framework is inspired by the experience gained in applying the Dublin descriptors for the evaluation and (re-)design of the Bachelor program Earth Sciences and Economics and the Master Program Environmental Resource Management at the VU University. The Dublin descriptors are described well by the Bologna Working Group on Qualifications Frameworks (2005). The MIRE program specifies learning objectives for each of its taught subjects, as can be witnessed from the course descriptions on the web (<http://www.uib.no/studieprogram/BATF-MIRE#uib-tabs-laringsutbyte>). As indicated in Table 1, I have chosen to cluster some of the queries and I have not studied the issue of marks achieved (5. karakterfordeling). Three clusters are used: the curriculum in itself, behavior and dynamics of and perception among the student population, and the institutional embedding. As said before, possible measures (queries 9 and 10) will only follow after the analysis.

Thirdly, three scenarios were used to rank applicability of different measures that could be taken to improve curriculum structure, content, student drop-out or whatever problem that arises from the analysis. These scenarios are:

1. A recognition of the importance of cross-disciplinarity for both research and education at Bergen University as explicitly addressed by the university's rector is also reflected in the allocation of new funding for staff, infrastructure and pioneering research projects for a considerable period of time (~10 years).
2. The Faculty of Mathematics and Natural Sciences acknowledges two of the major problems in the current organisation of the MIRE Bachelor program, but there is only limited economic support to make major changes. Instead, cooperation is sought in Bergen as well as Norway and Europe through the joint degree possibilities of the Erasmus Program.
3. Faculty and Department have no financial means and put no priority in initiating a master program in Environment and Resources. Therefore only issues within the curriculum can be accommodated.

³ See preface and annex 3, my cv. See also note 4.

Box 1. Overall future perspective as announced on the website (<http://www.uib.no/studieprogram/BATF-MIRE/BATF-MMIRE#>).

Kva kan du bli - yrkesveggar

Bachelorprogrammet i miljø- og ressursfag legg vekt på auka samfunnsorientering og erkjenning av kor viktig det er å ha ein tverrfagleg bakgrunn. Tverrfagleg utdanning gir eit godt grunnlag for å utvikle den kompetansen som dei enkelte verksemdene treng. Dermed er din kompetanse ein ressurs i næringsliv og forvaltning. Det er dessutan nyttig med ein tverrfagleg bakgrunn dersom du siktar deg inn mot ei forskarkarriere.

My translation of what is announced as future employment, hence the overall objective of this BSc program:

This bachelor program in Environment and Resources emphasizes a strong societal orientation and recognizes the importance of a cross-disciplinary background. Such a cross-disciplinarity⁴ gives a good basis to develop the competences needed for specific employment fields. Thus, your competence is valuable in both entrepreneurship and government authorities. In addition, it is useful to have such a cross-disciplinary background if you consider a future in research.

Main findings

Educational, the curriculum

The *learning objectives* are well-specified up-front on the website and match with a clear over-arching specification of the future perspective for the student once the degree is achieved (Box 1, and Table 2). Potential students considering to enroll for this course get an overview of the learning objectives and a potential professional future. I have not gauged among students how they perceived the recruitment activities at secondary schools, but those I spoke to confided to me that they were highly motivated to engage in such a multi- or cross-disciplinary program so I conclude that these learning objectives are disseminated well.

However, I have probed among teachers and students into the cross-disciplinarity of program and individual courses, and here I perceive a major problem. The curriculum has only two courses that are dedicated and mandatory to the MIRE program itself, MNF110 (environment, climate and human history; <http://www.uib.no/emne/MNF110>) and MNF115 (a natural sciences perspective on sustainable development; <http://www.uib.no/emne/MNF115>), respectively. Both courses are open to any students from the faculty, have an introductory level, use mainly classical lecturing, and have little or no exercise in cross-disciplinarity. Student achievement is tested in a written exam (MNF115 has 30% written assignment). Cross-disciplinarity is a major aspect in the learning objectives of this program (box 1 and table 2). It is a complex mixture of knowledge and skills that is not straightforwardly established. Unfortunately, I did not find evidence for working formats that would stimulate the acquisition of knowledge, competence and skills to be able to 'apply the cross-disciplinary theoretical basis of the natural, societal and managerial system to carry

⁴ Note that I have not separated out inter- from transdisciplinarity here, or have entered into a debate where the focus should be in this program (see f.x. Jacobson & Robinson, 1990 or Graybill et al., 2006). For the sake of simplicity I presume that cross-disciplinarity here implies that the program offers both different relevant mono-disciplinary subjects and courses as well as a range of formats fostering their integration.

Table 2. Learning objectives (<http://www.uib.no/studieprogram/BATF-MIRE#uib-tabs-laringsutbyte>)

In Norwegian	In English
<p>Kunnskap: kandidaten</p> <ul style="list-style-type: none"> • kjenner til grunnleggende biologiske, kjemiske og geografiske prosesser som styrer og driver utviklingen i natursystem • kjenner til grunnleggende økonomiske prinsipp med relevans for naturmiljø og naturressursbruk • har bred og basal kunnskap om viktige tema i miljø- og ressursammenheng • har fordypet seg i noen sentrale miljø- og ressursrelaterte arbeidsområder • kan drøfte sentrale problemstillinger og paradigmer i miljø- og ressursforvaltninga • har kjennskap til det teoretiske grunnlaget for planlegging og forvaltning av miljø og ressurser 	<p>Knowledge, the candidate</p> <ul style="list-style-type: none"> • Knows the basic biological, chemical and geographical processes that drive the dynamics of the natural system. • Knows the basic economical principles that have relevance for environment and natural resource use • Has a broad knowledge of important themes in environment and natural resources • Has become acquainted with some central working fields in environment and natural resources • Can work out central problems and paradigms in environmental and natural resource management • Has knowledge of the theoretical basis for planning and management of environment and natural resources
<p>Ferdigheter: kandidaten</p> <ul style="list-style-type: none"> • kan forklare generelle miljø- og ressursrelaterte begreper og sette disse i sammenheng • ser sammenhenger mellom menneskelig aktiviteter og miljøendringer • kan anvende det tverrfaglige teorigrunnlaget om natur-, samfunns- og forvaltningssystem til å foreta helhetlige og kritiske vurderinger og analyser av forvaltningspraksis • kan fremheve betydningen av en tverrfaglig tilnærming til samfunnsaktuelle problemstillinger • kan formidle tverrfaglige miljø- og ressursrelaterte tema opp til bachelorgradsnivå 	<p>Skills, capacities: the candidate</p> <ul style="list-style-type: none"> • Can explain general environment and resource related concepts and put these in context • Sees the relations between human activities and environmental change • Can apply the cross-disciplinary theoretical basis of the natural, societal and managerial system to carry out integrated and critical evaluations and analyses of the management practice • Can put forward the importance of a cross disciplinary approach to society's current problems • Can publicly convey and disseminate cross-disciplinary environmental and resource related themes at the bachelor level
<p>Generell kompetanse: kandidaten</p> <ul style="list-style-type: none"> • kan innhente og vurdere informasjon og kritisk vurdere primære og sekundære informasjonskilder • kan analysere problemstillinger i et tverrfaglig perspektiv • kan vurdere usikkerhet rundt observasjoner, teorier og metoder • kan gi faglig kompetent skriftlig og muntlig framstilling av vitenskapelige tema • har reflekterte holdninger om etiske spørsmål om forskning, praksis og formidling 	<p>General competences: the candidate</p> <ul style="list-style-type: none"> • Can acquire and evaluate information and can critically evaluate primary and secondary sources of information • Can analyse problems in a cross-disciplinary perspective • Can evaluate uncertainty in observations, theories and methods • Can give competent written and oral presentations of scientific themes • Has a self-reflected position on ethical questions regarding research, the practice (of science application¹) and public dissemination

¹my insertion, type of practice is not specified in the Norwegian text

out integrated and critical evaluations and analyses of the management practice'. I also did not find a form of stepwise increase in complexity across the three years where this is gradually developed, nor any form of group work or field exercises dedicated to cross-disciplinarity or the integration of multiple disciplines. This implies that the program implicitly assumes that students will internalize the integration of different disciplines mostly by themselves and without much formal education, pedagogic support or practical training. To my judgment this is a major flaw in the curriculum of MIRE given the explicitly stated learning objectives.

A second issue is the absence of an individual, independent or joint research project of some substance. I have understood that the faculty has decided that this is not obligatory and that 10 credits are distributed over different courses that have individual writing assignments. In my view, the writing of an individual thesis, if only of 10 credits, contributes most importantly to the more complex learning objectives that are also defined for the current program (Table 2, third, bottom part).

I have a third, though less important major issue with the learning objectives. Upon re-reading I came to wonder how the authors of this text would envisage a practical work out of the following objective: 'Can apply the cross-disciplinary theoretical basis of the natural, societal and managerial system to carry out integrated and critical evaluations and analyses of the management practice'. What are actually the theoretical bases of respectively the societal and the managerial system, and do these two differ in any substantial way? Can we design course material that will foster this? I may have misunderstood this, and hence mistranslated the Norwegian, but high-heeled rhetoric runs the risk of stumbling. In short, I suggest the program board to re-evaluate the learning objectives, identify where and how these objectives are met in the individual courses and consider re-alignment of existing courses and the development of new courses.

Working formats chosen in the courses offered in MIRE are geared towards learning objectives in other bachelor programs, since most courses are shared with these other programs. Where these involve activating work forms such as lab or field work and group assignments this is highly relevant to ensure a better learning result. More engaging educational formats are being offered in the Centre of Excellence in Biology Education BIOCEED, administered by the same Department of Biology (www.bioceed.no). This centre could be engaged to develop course work dedicated to cross-disciplinary teaching.

The last point to be addressed here is the question whether the curriculum is '*doable*'. I base my analyses mainly on the comments of the students. These stressed that the 80 ECTS free choice are only free when a student is not preparing for one of the four follow-up monodisciplinary master programs at UiB (Fig. 1). Otherwise, the curriculum is filled with obligatory packages that allow entrance to either Biology, Geography, Chemistry or Economics. This means that the curriculum is only really '*doable*' within the scheduled time ('innen normert tid') when a student strictly adheres to such a package, or when she/he decides not to bother about this and compile a program of personal choice.

Students: recruitment, performance and job outlook

Student recruitment from secondary schools does not appear to be a problem. The Norwegian government has indicated that bachelor programs should have at least 20 students in the inflow, and the program manages to maintain an influx around 30. However, the proportion of drop-outs is

substantial, particularly during the first semester (Fig. 1). I discussed this with staff, students and program management because I perceived this as a potentially serious problem. To my surprise, lecturers reflected on this quite positively, since ‘students use this opportunity for self-reflection and to make a more profound orientation on their future’, and ‘most of our bachelor programs have similar substantial losses during the first year’. Administration and students added some nuance and suggested that most apparent drop-outs from MIRE in fact decide to continue directly in bachelor programs Biology, Chemistry or Geography, since they will end up in these master programs anyway. However, this is not reflected in the statistics provided by Magnus Nerheim: in the cohorts since 2006 17 students have moved to other BSc programmes in Bergen. If these are roughly 9-10 cohorts of 20 students this corresponds to about 10%. From those students that do acquire their MIRE bachelor diploma and continue for a masters in Bergen (27%), the majority continues in a geography masters. Given the inherently multidisciplinary nature of geography, and the current research focus areas (<http://www.uib.no/en/geografi>: notably physical geography, environmental and landscape geography, development geography and economic geography including regional planning), this is not surprising.

I conclude that a bachelor program that does not offer the cross-disciplinarity it promises, and generates little choice other than the obligatory course packages qualifying for these mono-disciplinary follow-up masters offered in Bergen, can only expect such student losses. I would value this loss as a serious issue, but it may be that from a university or faculty perspective the net benefit in numbers of study credits acquired is quite positive.

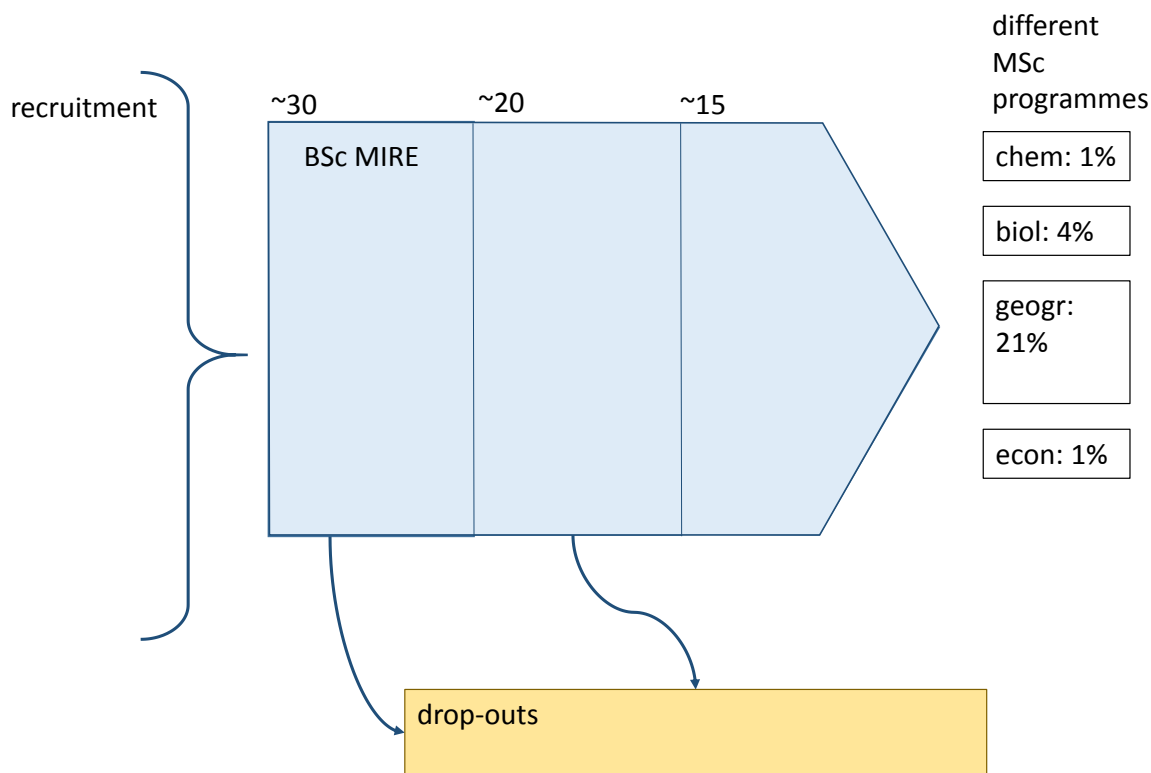


Figure 1. Schematized through flow of student cohorts in the MIRE bachelor program based on statistics presented by the program board. Outflow statistics to masters is summed over 2005-2015. Of those that acquire a bachelor diploma, 73% does not continue for a master in Bergen (data Magnus Nerheim).

Student performance. As explained in the section on approach, I have decided not to assess this, because other issues appeared more important. Some successful and appealing *job outlooks* are presented on the website. In the Norwegian context, these are only relevant in combination with a completed master degree. I have no empirical material to judge whether students with a MIRE bachelor perform differently from those with the same master but a monodisciplinary bachelor. I will therefore not make any judgments on the future job perspectives for students that complete MIRE.

Institutional embedding and staff engagement

Individual *staff engagement* to the program is limited. When discussing this with the students they explain that the only individual they associate with the program is the administrative study coordinator (studieveileder). The teachers explained that this has all to do with the historical development of the formal institutional linkage (forankring) of the program. In the past, it was 'owned' by a dedicated center for integrated water studies ('Senter for miljø- og ressursstudier'-'Centre for Studies of the Environment and Resources') but this was discontinued at the end of the funding period. Two of the three lecturers interviewed feel personal attachment to MIRE, and that was probably one of the reasons why they were selected for this interview. Andreas Steigen had overall responsibility for the program before he left to the Gambia, and Eirik Amundsen teaches a vital course in Environmental Economics (ECON116) in the program. I conclude that staff engagement with MIRE is overly limited and I suspect that this must be an important drawback in conveying the university's position on the relevance of the subject matter. Preaching cross-disciplinarity should be reflected to some extent in the practice that is encountered in the real life of students. Related cross-disciplinary research at UiB takes place at the department of geography and at the Bjerknes Center for Climate Research (<http://www.bjerknes.uib.no/en/>). Students interviewed noted that the Bjerknes Center will only take up master students and is mainly on the natural science side of climate research and an inspection of the website can only confirm this. Still the socio-economic dimensions of scenario articulation and regionalization, as well as adaptation and mitigation strategies could be research subjects of interest to MIRE students.

Organization and *reflection on student feedback* appears to be structured in an orderly fashion. The program board has student members, curricular changes are discussed and student concerns are being heard in the program board. The student representatives for MIRE are organized in a committee (fagutvalg) and these meet and discuss matters of importance to their curriculum.

Formal *institutional embedding* is in the Department of Biology under the Faculty of Mathematics and Natural Sciences. Students, teachers and administrative staff reflected upon this as an important but often implicit resistance to a further development and maturation of the cross-disciplinary program MIRE. The students explicitly perceive this as the main ground for what they perceive as being second priority students. Students also make the link to what they perceive as a 'home' (faglig hjem). Where other programs have a boardroom (kontor) and a study hall, MIRE lacks this. This is not the same as a formal embedding, but it does contribute to a perception of being second priority students.

At present, I conclude that the formal responsibility for MIRE under the Department of Biology does not ensure an optimal organization of the curriculum. At the same time, allocation of this responsibility under another department may not have made a great difference. From my external position, with

only limited internal insight, a formal embedding under geography would seem more fitting. A small but active multidisciplinary research group would have easily catered for the perceptive aspects of this issue. Its research subjects necessarily cannot cover all subjects taught in MIRE, but several interesting interfaces between natural sciences and social sciences could be used to generate such a research group. This group could also have all or part of the formal responsibility for MIRE. Staff of the group would recognize responsibility because they feel 'ownership', but also because a significant part of the income from the study credits would flow to this group. If cross-disciplinarity is taken seriously, such an interface should span the beta-gamma disciplinary width.

Answering the two overarching questions

Is this program organized in an optimal and appropriate way given the current boundary conditions?

The most obvious answer to this question is that this depends on what we see as boundary conditions. I therefore have drafted these three scenarios for use in the next section. The program may well be organized financially in a highly efficient way. However, it does not meet its explicitly stated learning objectives, so one cannot speak of 'optimal' or 'appropriate' in this sense. Therefore my answer to the question is negative.

What external boundary conditions shall we have to face and try to influence to improve the study in terms of quality and expediency?

In my view, the issue is both expedience and quality. To appropriately meet its own learning objectives, the program should incorporate several cross-disciplinary subjects in courses, preferably building up in complexity in a systematic manner throughout the three years. This may not be seen as crossing an external boundary, but it depends on current organizational and curricular conditions within and outside the faculty. Other obvious boundary conditions are the absence of an obvious follow-up master program in (part of) the same cross-disciplinary domain. I will elaborate on this in the next section.

An important issue that has not been covered yet is the mismatch between those who have formal responsibility and those who suffer most in the current situation. Here it is department or faculty leadership as the sellers vis-à-vis the consumers of education, the students. To extend the parallel of sellers and buyers, we can conclude that the product that is ultimately sold to the consumer does not completely match with what is promised in the brochure and on the internet.

Advice

The convolute problem complex of the MIRE program can be dissected in different ways. I have chosen to start from the learning objectives, as these are formal and explicit, and then look at roles and perceptions among the two main, immediately involved stakeholder groups, teaching staff and students. I concluded that students, as consumers of this particular form of higher education, get less than is promised. Students however are not powerless, and it is anecdotally illustrative that one of the teachers suggested that students should directly contact the rector of UiB to confront the situation of MIRE with his recent focus on cross-disciplinarity.

Table 3. Possible measures that can resolve the three problems mapped out against the three scenarios

problem	Scenario 1, UiB recognizes the importance of cross-disciplinary environmental research and teaching and dedicates substantial funds to this	Scenario 2, the faculty recognizes two major problems but have only limited resources – cooperation outside UiB is sought	Scenario 3, faculty nor institute has financial means or priority for MIRE, so only measures within the curriculum are possible
Learning objective cross-disciplinary not met	Redesign the curriculum using a task force with external members, revise learning objectives with a view on a follow-up masters. Further as in scenario 2.	Develop joint, multi-disciplinary field courses; adjust the curriculum to make space for these. Focus on working formats suitable for cross-disciplinary and invoke the center for educational excellence BIOCEED. Consider to truncate the number of different master options for a MIRE student and only maintain those that get sufficient numbers now (Biology, Geography), this would probably allow a narrower selection of basic courses to create free study credits.	Adjust learning objectives and downscale ambitions. Be realistic and fair in advertising and dissemination. Reduce the different master programs that are potentially open and use the free ECTS for some multidisciplinary fieldwork in the third year.
No follow-up cross-disciplinary master's program	Together with BIOCEED a new and competitive cross-disciplinary international master will be developed in cooperation with several European partners in a joint degree program. This will also be used for an Erasmus ITN proposal. Opening up for and gearing the program towards international students could generate a large influx of students as witnessed by ERM ¹	The same as in scenario 1.	An adjusted master program or orientation within geography with entrance criteria geared better towards MIRE.
No dedicated cross-disciplinary research group	UiB opens up an internal call for one or few new cross-disciplinary and excellent research groups. These will have one permanent professor, research consumables for 6 years and two tenure track positions and 2x2 PhDs. In addition, the group will have formal responsibility for the MIRE bachelor and will be engaged in the development of a new cross-disciplinary master program.	An interfaculty working group can receive limited financial support to identify and work on a joint research project that can use many master students and has a high regional media profile. A professor 2 position is reserved for an identified high profile and active scientist with a cross-disciplinary research portfolio.	Not possible to finance such a group. Possibly a professor in Geography could be identified as responsible contact for MIRE's study content.

¹ the 1 yr master program ERM is taught and embedded at the Institute for Environmental Studies, VU University, Amsterdam (<http://www.environmentmaster.nl/>). It started with 47 students in 2003 and grew to 64 in 2009.

Based on the above, I have imagined several possible measures and aligned them along the different scenarios (Table 2). I have not included the trivial solution of a termination of the program. Different measures have different feasibility, and even in the most adverse scenario, which is close to business-as-usual, some measures appear quite feasible, given some institutional willingness to change. Cross-disciplinary in itself is not an obligatory higher order goal. It happens to be so that environmental problems are often wicked problems and these are generally not resolved with natural sciences or engineering solutions alone. Instead, societal dimensions are often underestimated in their role as drivers. To be able to understand these interactions, weigh them and address possible alternatives is an important asset for the coming generations of environmental scientists, managers and consultants.

Here the cross-disciplinary MIRE program can contribute substantially. I have extracted three problems as major bottlenecks in this, and concluded to see others as minor, such as student recruitment. In my view, MIRE needs:

- (a) A substantial revision of its learning objectives and course portfolio to explicitly accommodate cross-disciplinarity;
- (b) A matching master program in environment and natural resource management;
- (c) A dedicated group of researchers that take the subject as an academic interest and can be a focal home for both bachelor and master students.

I cannot step into the responsibility of the institutional leadership and will not judge strategic decisions nor be able to gauge economic opportunities and limitations. I have sketched possible solutions to overcome these bottlenecks and I think there is considerable potential on the job market for these students when they are truly trained to think in a cross-disciplinary way. In the end, this is only an expert opinion. Whatever scenario will unfold in the coming months, I hope that this report will form a clear advice to organization and students.

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Annex 1. Terms of reference (In Norwegian)

Evaluering av bachelor-programmet Miljø- og Ressursstudier (MIRE) ved Universitetet i Bergen Rapport levert før 1. desember 2015

Informasjon og mandat:

Programsensor skal vurdere studieprogrammet sin profil og struktur, forekomst av felles undervisning og emner spesielt utviklet for studieprogrammet, høve til studieopphold i utlandet, faglige og sosiale aktiviteter.

Vurderingene fra programsensor skal særlig omfatte synspunkt på:

1. Pensum, studieopplegg og undervisning, og om valg av undervisnings- og vurderingsformer er i tråd med fastsatt læringsutbytte for studieprogrammet
2. Vurderingsordningene som blir benyttet i studieprogrammet. Som grunnlag skal programsensor få en oversikt over de ulike emnene som inngår, samt dokumentasjon av vurderingsordningen og sensorordningen for det enkelte emne i studieprogrammet.
3. Den praktiske gjennomføringen av kurset
4. Søkertall/studieplasser, gjennomføringsprosent, strykprosent og frafall (informasjon vil bli gjort tilgjengelig)
5. Karakterfordeling (blir gjort tilgjengelig)
6. Gjennomført studentevaluering (blir gjort tilgjengelig)
7. Programstyret sine vurderinger og forslag til forbedringer (referat frå møter i programstyret vil bli gjort tilgjengelig)
8. Hvordan kvaliteten på bachelor-programmet vurderes i forhold til tilsvarende studieprogram ved andre læresteder
9. Tiltak som kan synliggjøre graden i arbeidslivet
10. Strategiske tiltak som kan øke gjennomføringsgrad og studenttilstrømming til studiet

Programsensor skal få utlevert relevant informasjonsmateriale og kan selv be om ytterligere dokumentasjon.

Programsensor skal også få høve til å komme i kontakt med tilsette og studenter for samtale om kvalitetsutvikling i studieprogrammet.

Sensorrapporten kan skrives på norsk eller engelsk. Vervet som programsensor blir honorert av fakultetet etter nærmere avtale. Rapporten skal leveres innen 1. desember.

To sentrale hovedspørsmål (fra e-post av Inga Kjersti Sjøtun):

- 3) Er studiet organisert på den beste og mest hensiktsmessige måten ut fra de rammebetingelsene vi har nå?
- 4) Hvilke rammebetingelser bør vi arbeide med i framtiden slik at studiet blir organisert på en bedre og mer hensiktsmessig måte?

NOTE FROM JAN VERMAAT

For ease of reference I have numbered the 10 specific queries, and I have included the two questions that were sent to me later.

Annex 2. Site visit scheme November 2, 2015

Tid	Hva	Med hvem
08:15 – 09:00	Møte med studiesjefer på BIO	Øyvind Fiksen (utdanningsleder Institutt for Biologi) Oddfrid T. K. Førland (studieleder) Synnøve Myhre (adm. sjef) Magnus Svendsen Nerheim (studieveileder)
09:00 – 10:30	Møte med programstyrerepresentantene	Inga Kjersti Sjøtun Tanja Barth (organisk kjemi) Grethe Meling (geografi) Fredrik Herdlevær Sagafos (økonomi/statsvitenskap)
10:45 – 11:30	Møte med studieadministrasjonen	Magnus Svendsen Nerheim Oddfrid Førland
11:30 – 12:30	Lunsj	Alle
12:30 – 14:30	Møte med studentene	Heidi Jensseter Johannes Bolstad Simon Bereksten Helene Dunlop
14:30 – 16:00	Møte med undervisere i MNF110, ECON116, FIL236 (tre kjerneemner i MIRE)	Andreas Steigen (m. fl. fiskesykdom) Eirik Schrøder Amundsen (statsvitenskap) Trygve Lavik (filosofi og miljøetikk)
16:30 ->	Middag	Alle

Annex 3. Short CV Jan Vermaat

Name: Prof dr ir J.E. Vermaat
First name: Jan
Date of birth: January 31, 1959
E-mail: jan.vermaat@nmbu.no



Jan Vermaat currently heads the Department of Environmental Sciences (IMV) of the Norwegian University of Life Sciences (NMBU) in Ås. Until summer 2014, he was professor in Earth Sciences and Economics (ES&E) at VU University, Amsterdam, headed the section with the same name and was director of the BSc and MSc programmes in ES&E. He was Associate Professor (UHD) at the Institute of Environmental Studies (IVM) at the VU from 2001-2010, and senior lecturer Aquatic Ecology at IHE-Delft from 1989-2001. His research interests are water quality, wetlands, catchment biogeochemistry, coastal ecosystems, spatial pattern, ecosystem services and in particular the interface between ecology, earth sciences and economics. He is co-editor-in-chief of Aquatic Botany since 2001. At the VU, Jan coordinated several courses at BSc and MSc level, including the field courses 'Spatial Analysis for Research', and 'Aquatic Ecology' as well as 'Ecosystem Services and Biodiversity', and chaired the examination board of the master program in Environmental Resource Management from 2003-2010. He lectured Environmental Sciences at Amsterdam University College. He (co-) supervised several PhDs and postdocs: Wilfredo Uy, Udomluck Thampanya, Hildie Nacorda, Sabine Körner (now Hilt), Harry Olde-Venterink, Peter Schippers, Rene Rollon, Hasse Goossen, Florian Eppink, Maria Gonzales Sanchis, Fritz Hellmann, Matt Helmus, Johanna Schild, and Zhou Ting. Jan defended his PhD in 1991 at Wageningen Agricultural University.

Recent projects in past 5 years

EU-FP6: Science and Policy Integration for Coastal System Assessment (SPICOSA, led Scheldt case). EU-FP7: European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation (RESPONSES, led biodiversity task); Restoring rivers for effective catchment management (REFORM, led ecosystem services task); United Nations-Global Environmental Facility-International Waters: Enhancing the use of science (UNEP-GEF-IW, expert). Smaller projects for World Bank, Lesotho Highlands Development Authority, Dutch Environmental Planning Agency, several Dutch Provinces and Water Boards, WWF The Netherlands.

Selected publications

Publication statistics: around 80 papers in ISI Web-of-Science journals, 20 book chapters and over 30 papers in professional journals since 1984, ISI H-index = 30.

Vermaat J.E. & Sand-Jensen K., 1987. Survival, metabolism and growth of *Ulva lactuca* under winter conditions: a laboratory study of bottlenecks in the life cycle. *Mar. Biol.* 95: 55-61

Vermaat J.E., Hootsmans M.J.M. & Van Dijk G.M., 1990. Ecosystem development in different types of littoral enclosures. *Hydrobiologia* 200/201: 391-398

Duarte, C.M., Marba, N., Agawin N., Cebrian J., Enriquez S., Fortes M.D., Gallegos M.E., Merino M., Olesen B., Sand-Jensen K., Uri J. & Vermaat J.E., 1994. Reconstruction of seagrass dynamics: age determinations and associated tools for the seagrass ecologist. *Mar. Ecol. Progr. Ser.* 107: 195-209

Vermaat J.E., Agawin N., Duarte C.M., Enriquez S., Fortes M.D., Marba N., & Uri J., 1997. The capacity of seagrasses to survive eutrophication and siltation, the significance of growth form and light use. *Ambio* 26: 409-504

Vermaat J.E. & Khalid H.M., 1998. Performance of common duckweed species on different types of waste water. *Water Res.* 32: 2569-2576

- Kamp-Nielsen L., Vermaat J.E., Wesseling I., Borum J. & Geertz-Hansen O., 2002. Sediment properties along gradients of siltation in South East Asia. *Estuar Coast Shelf Sci.* 54: 127-137
- Olde Venterink H., Wiegman F., Van der Lee G.E.M. & Vermaat J.E., 2003. Role of active floodplains for nutrient retention in the river Rhine. *J Env Qual* 32: 1430-1435.
- Schippers P., Vermaat J.E., De Klein, J. & Mooij W.M., 2004. The effect of atmospheric CO₂ elevation on plant growth in freshwater ecosystems. *Ecosystems* 7: 63-74
- Brander L., Vermaat J.E. & Florax R.J.G.M., 2006. The empirics of wetland valuation: a meta-analysis. *Env Resource Econ* 33: 223-250
- Thampanya U., Vermaat JE, Sinsakul S. & Panapitukkul N., 2006. Coastal erosion and mangrove progradation of Southern Thailand. *Est Coast Shelf Sci.* 68: 75-85
- Vermaat, J.E., Dunne, J., Gilbert, A.J, 2009. Food web structure properties: can we minimize their number? *Ecology* 90: 278-282
- Vermaat, J.E., 2009. Seagrasses: meadow-forming, clonal angiosperms with a key role in shallow coastal waters. *Persp. Plant Ecol. Evol. Syst.* 11, 137-155
- McQuatters-Gollop, A., Gilbert, A.J., Mee, L.D., Vermaat, J.E., Artioli, Y., Humborg, C., Wulff, F., 2009. How well do ecosystem indicators communicate the effects of anthropogenic eutrophication? *Estuar Coast Shelf Sci* 82: 583-596
- Vermaat, J.E. & Bouwer, L.M., 2009. Less ice on the Baltic reduces the extent of hypoxic bottom waters and sedimentary phosphorus release. *Estuar Coast Shelf Sci* 82: 689–691
- Vermaat, J.E. & Hellmann, F., 2010. Covariance in water- and nutrient budgets of Dutch peat polders: what governs nutrient retention? *Biogeochemistry* 99:109-126
- Dias. A.T.C., Hoorens, B., Van Logtestijn, R.S.P., Vermaat, J.E., & Aerts R. 2010. Plant species composition can be used as a proxy to predict methane emissions in peatlands after land-use changes. *Ecosystems* 13: 526–538
- McQuatters-Gollop A. & Vermaat J.E., 2011. Covariance among North Sea nutrient and climate drivers: consequences for plankton dynamics. *J Sea Res* 65: 284-292
- Vermaat JE, Estradivari, Becking LE, 2012. Present and future environmental impacts on the coastal zone of Berau (East Kalimantan, Indonesia), a scenario analysis. *Reg Env Change* 12:437–444
- Vermaat JE, Eleveld MA, 2012. Divergent options to cope with vulnerability in subsiding deltas. *Climatic Change* 117:31–39
- Maina J, De Moel H, Vermaat JE, Grove C, Bruggemann H, Gillaume MMM, Madin J, Mertz-Kraus R, Zinke J, 2012. Linking coral run-off proxies with hydrology and land use in Madagascarian catchments. *Mar Poll Bull* 64, 2047-2059.
- Vermaat JE, Broekx S, Van Eck B, Engelen G, Hellmann F, De Kok JL, Van der Kwast H, Maes J, Salomons W, Van Deursen W, 2012. Nitrogen source apportionment for the catchment, estuary and adjacent coastal waters of the Scheldt. *Ecology & Society* 17(2): 30; <http://dx.doi.org/10.5751/ES-04889-170230>
- Maina J, De Moel H, Zinke J, Madin J, Vermaat JE, 2013. Counteracting forest conversion and climate change impacts of sediment supply to coral reefs in a global biodiversity hotspot. *Nature Communications* 4:1986
- Wagtendonk AJ, Vermaat JE, 2014. Aesthetic perception of landscapes: developing a low resolution GIS-evaluation method. *Landscape Urb Plann* 124: 85–92
- González-Sanchis, M, Murillo J, Comin, F, Vermaat JE, García-Navarro P, 2014. Modeling sediment deposition and phosphorus retention in a river floodplain. *Hydrol Proc.* DOI: 10.1002/hyp.10152
- Vermaat and many others, 2015. Assessing the societal benefits of river restoration using the ecosystem services approach. *Hydrobiologia* DOI 10.1007/s10750-015-2482-z

Books and chapters

- Vermaat J.E., Bouwer L., Turner K. & Salomons W. (eds), 2005. *Managing European coasts: past, present and future*. Springer, Environmental Science Monograph Series, 387 pp.
- Vermaat, J.E., 2009. Effects of recreation and commercial shipping on inland waters. In: Likens G.E. (ed.) *Encyclopedia of Inland Waters*, vol 1, 259-263.
- Vermaat JE, Apitz SE, Blum W, Harris B, Hellmann FH, Salomons W, Van Maasackers T, 2013. Framing the uncertain future: articulating SRES-scenarios for European river basins. in Brils J, Brack W, Mueller D, Negrel P, Vermaat JE, (eds) *Towards risk-based management of river basins*. Handbook of Environmental Chemistry vol 29, Springer.
- Vermaat HE, Eilers J, Helmus M, 2015. An ecological basis for understanding the role of biodiversity in the provision of ecosystem services. In Van Beukering P, Bouma J, (eds) *textbook on ecosystem services*. Cambridge Univ Press