Course analysis – Applied Hydrology AE2610, VT 2024

Credits: 7.5 hp

Course responsible and examinor: Anders Wörman
Contributing teacher: Joakim Riml
Invited lectures: Tyréns AB and the Swedish Meteorological and Hydrological Institute (SMHI)

Examination criteria
Mandatory exercises, 3.0 hp
Written examination, 4.5 hp

No. students: 29 registered, whereof 28 followed the course and 27 took the written exam.

Course content and learning objectives

Applied Hydrology (AE2610) is a course about runoff processes at the catchment scale or, in other words, a course about catchment hydrology. During this course you will learn more about how water runoff processes can cause floods of rivers and urban environments and about their importance for assessing the water availability for irrigation, municipal water-use and hydropower. The course links important mechanisms in terrestrial hydrology to provide a systematic overview of runoff processes, including evaporation and heat fluxes in water, groundwater and surface water flows. You will particularly apply theoretical methods, but also learn to use computational softwares dedicated to deal with runoff in rural and urban landscapes as well as more generic modeling tools such as Matlab and Comsol Multiphysics.

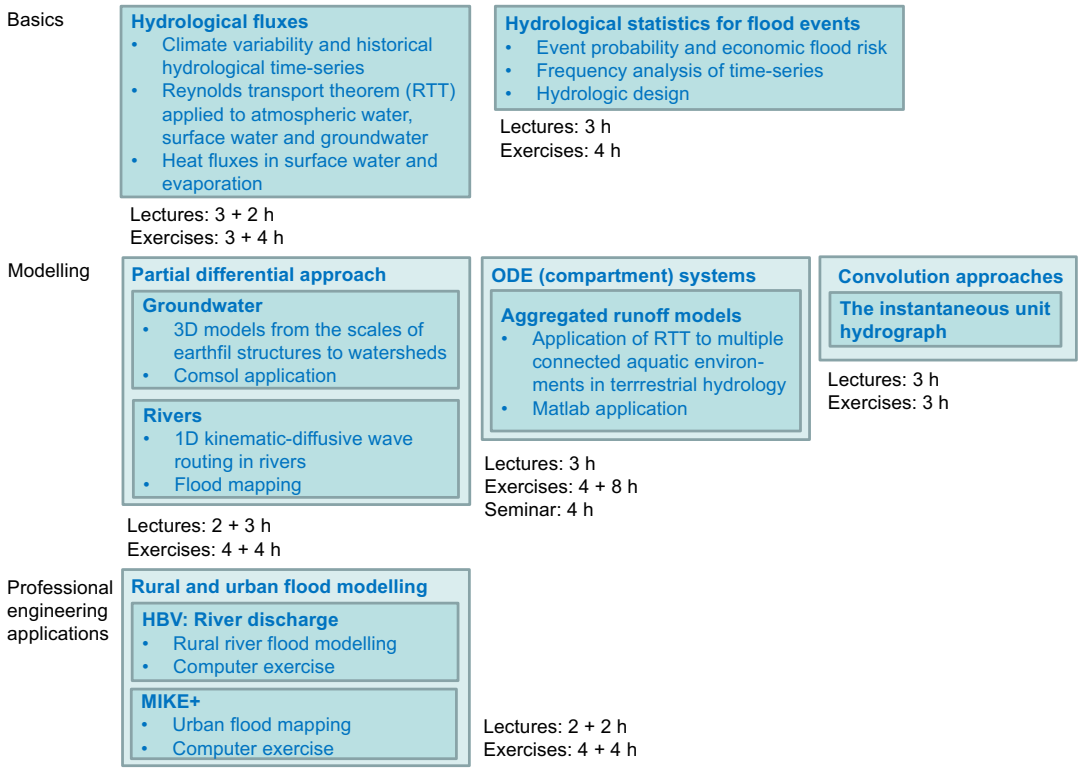

Fig. 1: Course content and teaching activities distributed on various aspects.

Teaching activities – types and extent

This course has been provided mostly on campus, but some lectures were provided on Zoom. The course is divided in 11 modules or sessions dealing with the concepts described in the figure above. About 1/3rd of the teaching activities are classroom lecturing and 2/3rd are based on groupwise exercises supervised by teachers.

This course consists of lectures and teacher supervised exercises, some of which are computer-based and some are theoretical assignments with manual calculations. All exercises can be conducted at the KTH campus, even if the supervision by external teachers is conducted online for a few of them. Reservations of computer rooms with the appropriate program installations are done according to the schedule presented in the study directions.

This is a summary of teaching activities:

- "Conventional" lecturing: 23 hours
- Guided / supervised exercises in groups: 44 hours, whereof about half is computer based and half is theoretical. Computer exercises are conducted using softwares like Matlab
  Comsol Multiphysics
  Mike+
  Tyréns AB gave an exercise on urban flood modelling using Mike+ and SMHI gave an exercise on rural runoff modelling using selective softwares.
- Report feed-back from mandatory assignments and one seminar evaluation.
- Written examination

The extent of teaching activities is slightly lower than corresponding courses within the (SEED) departments subject disciplines. The total staffing time of the course is 14 – 16% of a yearly full time (or 0.019 – 0.021 full time/ECTS credit) compared to the average course with a staffing of 20%. Since, the required teaching time depends not the least on the number of students, learning objectives and pedagogical requirements, this comparison only gives a qualitative indication that the student-teacher contact time is close to average in extent.

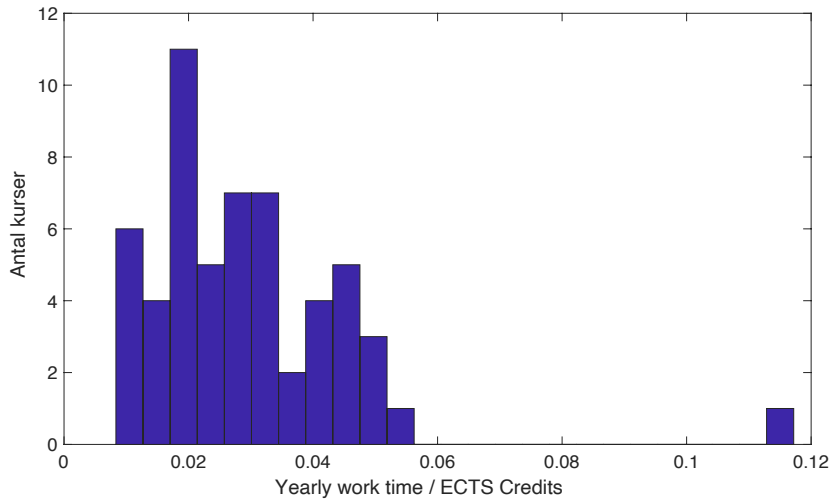

Fig. 2 Teacher led time per ECTS credit for all (most) courses at SEED (for 2023).

Results from course questionnaire

The course evaluation is based on a written questionnaire handed out on paper in connection with the written examination. 27 of the 29 registered students took the written exam and 25 completed questionnaires were received in return. Answers could be provided from 1 (I do not agree) to 5 (I fully agree) with the following mean values:

1. This course was very interesting from an educational (academic) point of view:	4.48
2. This course felt important for my future occupation and as practitioner:	4.52
3. I felt that the content of the course was useful:	4.48
4. This course stimulated me to study actively:	4.24
5. The lectures were helpful to comprehend the material of the course:	4.04
6. The exercises were interesting and helped my learning:	4.36
7. The teachers responded to feed-backs from (listened to) us students:	4.80
8. I felt that I had enough time to comprehend the material:	3.72
9. I had the scientific prerequisite for this course:	4.28
10. The examination reflected the content of the course:	4.26

The free text comments provided by students on open questions are provided in Appendix 1.

Examination results

The examination was based on a) mandatory exercises reports (3 credits) and b) a written exam (4,5 credits). The course comprises nine (9) mandatory assignments and one "bonus assignment" (providing 2 credits on the written exam), which were conducted groupwise under supervision of one teacher. This teaching form is believed to make the student work actively during the course and the groupwise collaboration among students facilitated communication and development of professional argumentation within the subject discipline. All 28 students that followed the course passed (got the grade G of) this part of the examination.

The result of the written examination is well distributed on almost all grades from F to A (Table 1), and that two students failed. Previous experience is that practically no student that actively follow the course fails the written exam, so a summary of exam question difficulty was produced in Table 2. It shows that a couple of questions (6 and 10) were particular difficult and which calls for some attention for future exam production.

TABLE 1: GRADE LIMITS (TOTAL CREDITS = 27 +2) AND GRADE DISTRIBUTION ON WRITTEN EXAM

	≥24	23.5-21.5	21.0-18	17.5-15.5	13-15	12.5-11	10.5-0
GRADE	A	B	C	D	E	Fx	F
NO. STUDENTS	5	7	8	3	2	0	2

Table 2: Average correct answer on each written exam question

Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**bonus**
% right	78,70%	61,11%	78,70%	66,67%	77,78%	31,48%	59,88%	64,81%	83,95%	34,57%	75,93%	96,30%

Course analysis and course development

This section covers the following: ”Åtgärder som genomförts efter tidigare kursanalys. Kursens starka sidor och svaga sidor utifrån kursvärderingen och lärares reflektion, även i förhållande till de förändringar som genomförts inför kursomgången”

From the course questionnaire, it is clear that the course is appreciated by the students, both lectures and exercises as well as the general scope. Constructive criticism that can be identified in the written comments includes

- The content is very broad and there are too many assignments
- More time is needed for manual calculation and the concept “räknestuga” was suggested as a possible additional activity

While the teachers of this course agree that the course content is broad, it is also the intention to cover watershed runoff processes in a comprehensive manner that to some extent is based on some pre-knowledge in hydrology and to present modelling approaches based on basic university math. The students report that the time available to follow the teaching activities and examination requirements is somewhat on the “low side” (3.72 on the scale 1 to 5), but probably not too low. The students feeling that the teaching activities could be expanded has some support in the statistics (in Fig. 2). The teaching team will follow this aspect of the course planning, but is not immediately considering a revision for this reason.

Further, a general result from the questionnaire was that teachers gave good feed-back during the course (4.8 on the scale 1 to 5). However, there was one explicit comment that the feed-back on the exercises was limited. This is partly true since there was a malfunctioning in the publication of corrected exercises in Canvas, which is something to consider in future courses.

From the teaching teams own experiences of the teaching activities, we can report the following reflections:

Computer exercises have not always worked well at earlier courses so extra much preparatory work was put on proper installation and testing of Mike+ as well as reducing the content of the exercise on HBV. These exercises worked really well this year according to the teacher’s assessment. The responsibility for the Mike+ exercise was changed from DHI to Tyréns AB and this has worked really well too, both the lecture and the exercise.

During and after each course, a list of experienced shortcomings is prepared and these shortcomings are addressed for the coming course. These things are often minor adjustments of lecture material and exercises, but also sometimes minor change of actual course content. The minor adjustments considered for this year is included in Appendix 2.

There was a particular observation of a “poor” result on one of the exam questions regarding modelling of groundwater, which will definitely be a motivation for improving primarily the exercise on groundwater modelling.

A general assessment can be that the course covers a lot of detailed topics of relevance for understanding catchment hydrology, which have e.g. led to quite a number of exercises.

Appendix 1: Practically all free comments (slightly shortened) provided by students on open questions regarding course content and objectives, course planning and organization, lectures and exercises and others:

The planning and organization of the course were satisfactory
The lectures and the exercises were extremely helpful
Everything was covered
Well organized and scheduled
Excellent if you are able to attend everything
Overall, very interesting, but more math than expected for an “applied” course
The organization of the course is so far the best of the whole master program
One suggestion is that you do not have to remember formulas in the examination, but rather with given formulas try to combine them to solve problems
Course planning was good
It was hard to get into the subject because the way the lecturing deviated from my previous experience
Good course content, course planning and exercises, but maybe “räknestuga” at the end of the course would have been nice
Fun course
Really difficult to remember all equations
Need more time to study after lectures
Need more time to complete exercises
Perfect course content
The exercises were really interesting
More time for the exercise on HBV would be good
The exercises could incorporate more examples of calculations
More time for manual calculation to actually understand
Slides are not useful
Very clear and doable course
Very good
Too many assignments
The lecture slides were a bit messy
Good course planning and good lectures
Great course overall
Very coherent content of the course
Good material was provided in advance and professors clearly stated the schedule
The course content is very broad, would have liked more depth in some subjects
The course was well planned and organized
I liked the exercises, but there were very many of them
Much useful to get to know about the theoretical methods
Very well organized
Exercises are challenging, yet interesting
Lectures are full of resources, which were helpful

Appendix 2: Main teachers note for improvements of the 2024 year's course

Förbättringar att göra (2025) från 2024 års kurs

Section 2

Oklarheter med enheter (meter vs foot) bör påpekas. Det står i läroboken att formeln gäller med SI-enheter och att tabellvärden på Mannings n-tal (Table 2.5.1) är i SI-enheter. Om man sätter in värden med enheten ”feet” så substitueras (1/n) mot (1.49/n).

The coefficient 1.49 is used as a unit conversion of n (given in Table 2.5.1) when variables are expressed in units of feet. If variables are expressed in SI units, this conversion is not needed. Please read short paragraph right after eqn. (2.5.6). Please, not that this unit conversion would not need to be considered in the written exam.

Section 5_Distributed routing

Slå ihop slides 9 – 10. Lägg härledningen som ”Appendix” i föreläsningsanteckningarna

Lumped routing – river discharge

Programmets (optim.m) pauser bör påpekas med en utskrift på skärmen!
Man kan ha en utskrift vid första körningen som beskriver programmet (räkningen för antal körningar kan t.ex. styras med en indatafil ”No_exectutions” som är en fil med bara en integer, 0 från början, men som sedan skrivs över med en etta.

Ta bort grafen med S.

Groundwater

COMSOL-instruktionen (”Step-by-step tutorials…”) stämmer inte exakt eftersom COMSOL har uppgraderats

Slide 2: Lyft först rollen av grundvatten som en del av ”Catchment hydrology and runoff”
Slide 17: Lyft identifieringen av ”Water divides” och symmetri-villkor (no flow). Är trycket hydrostatiskt längs denna linje?
Slide 23: Lite oklar. Ta bort vattendragsnärverket o diskutera enbart gränserna. Flytta till efter slide 17?

- På tentan den 11/3 -24 fanns en kortfråga om randvillkor baserat på samma figur som i övningen ” **Exercise: Seepage flow in soil slopes”.** Förmodligen förstår inte studenterna alls randvillkoren
  - Dirichlet (head)
  - Von Neumann (gradient)

  Samt särskilt implementeringen i form av gradient och flöde från Darcy's lag. I övningsuppgiften förklaras inte detta så bra, vilket gör att uppgiften skulle kunna utveckla detta (t.ex. att $q = -K \partial H/\partial n = 0$ används som villkor på vissa ränder).