Yearly Report 2009

L a b M a t h - I n d o n e s i a

Date: **15 August 2010**

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Introduction
Since the foundation of **LabMath-Indonesia** at 1st June 2005, this is the fourth annual report, covering the year 2009.
The mission and ambition of LMI are shortly described as follows.

Mission

LabMath-Indonesia is an independent non-profit research institute aimed to facilitate the execution of scientific research and to disseminate the results to the community. In order to achieve the aim, LMI advocates and stimulates the use of mathematical modelling and simulation in various disciplines for real-life problems of any kind.

Ambition

In order to fulfil the mission, LMI organises various activities that can be divided into the LMI-Programme, LMI-Research and LMI-Residency.
Besides this, LMI has facilities that support the activities and that can be used on a shared basis.

All the activities will stimulate in their specific way the use of modern modelling & simulation methods. Although mathematical methodology and reasoning are the backbone, the aim is to disseminate the methods and results to students, researchers and practitioners from many disciplines; human resource development is a natural consequence of the activities. For the execution of the activities, close relations and collaboration with national and international scientists and practitioners are vital. Internationalization activities support exchange of students by providing advice and recommendations.

LabMath-Indonesia executes the activities as part of the foundation Yayasan AB, officially recognised and registered by the Ministry of Justice of the Republic of Indonesia, (Menteri Hukum dan Hak Asasi Manusia Republik Indonesia) under number C-85.HT.01.02.TH2006, Dated 9 January 2006.

This report gives account of the activities that are executed in the year 2009 to fulfil the mission and to show the results of the ambition.

Contents

I. LMI-Programme

The LMI-Programme consists of courses of various characters that are organised on a regular basis and of conferences and symposia. The topic and targeted participants will vary depending on the activity.

The LMI-Programme contributes to the mission in terms of Human Resource development, since a primary aim of most course and conference activities is to select and further develop bright young people, providing the 'brainware' for future Indonesian research activities.

In 2009, one 2-week **Research Work Shop *Tsunami Modelling & Simulation*, a 2-day International Workshop *Coastal Oceanography* and a 3-day Symposium on *Coastal Zone Management*** were organised.

The RWS consisted of one (advanced) course week, followed by one project week in which participants execute in the spirit of research training one of a number of projects in a small group. Best performers were awarded with continued activities and coaching for further personal development. The contents of the Research Work Shops were designed and executed by national and international lecturers, taking into account a diverse disciplinary background of targeted participants.

The International Workshop and the Symposium were organised to finalise the APN project on Coastal Zone Management.

Besides this, LMI gave support to the organization of a Master Class as part of the fifth KNAW Open Science meeting in The Netherlands.

We describe these activities briefly below.

I.1. RWS *Tsunami Modelling & Simulation*

12 - 23 January 2009, 1 week Courses and 1 week Projects (SRO: GeoMath)

Various aspects of tsunami simulations were the topic of this RWS. Lecturers came from Indonesia (Dr. Hamzah latief, Prof.dr. Sri Widiyantoro, Institut Teknologi Bandung and Didit Adytia, LabMath-Indonesia) and the Netherlands (Dr. Vatvani, Deltares). In the first week, 30 participants could be accommodated to take part in the lectures and exercise sessions. In the consecutive second week of executing projects, we had to reduce the number of participants to 20. Of the 30 participants, 14 were S1, S2, S3 students and recent graduates; they came from 5 different universities; the other participants were 5 staff members from 4 universities, 9 participants from 6 different RI governmental institutions, and 2 staff members from Malaysian Ministry of Environment. See the announcement at the end of the report.

I.2. 2-day International Workshop *Coastal Oceanography*

16-17 May 2009,

As part of the execution of the APN project on Coastal Zone Management, the workshop addressed various topics on coastal oceanography in an instructional way, without losing the perspective of the total environmental aspects. This symposium attracted 32 participants, who followed lectures from 7 lecturers; see the description at the end of the report.

I.3. 3-day International Symposium on *Coastal Zone Management*

18-20 May 2009

The 3-day symposium, different than the preceding workshop, addressed many different aspects of Effects of Climate Change on Coastal Zone Management. In total 16 lecturers gave their presentation for the 40 participants; see the description at the end of the report.

I.4. KNAW OSM and UT-ITC Master Class *Water Research and Management*

18-20 November 2009

The fifth Open Science Meeting 2009 of the Netherlands-Indonesia scientific cooperation was held for the first time in The Netherlands under the title "Science, Innovation and Society'. As part of this bi-annual meeting, the University of Twente together with ITC was one of 5 universities where a 'masterclass' was organized following the two-day general meeting in Amsterdam and The Hague. LMI gave large support to this UT-ITC Master Class by designing the programme and delivering several of the lecturers. In total 30 participants followed lectures of 17 lecturers on various topics related to water (environmental water, coastal waves, fundamental fluid dynamics, earth-observation with satellites) and about entrepreneurial aspects of scientific results.

I.5. Buletin Pemodelan Matematika

LabMath-Indonesia wants to promote the application and show the usefulness of mathematical modelling to a large audience, and some of the activities are directed towards secondary schools.
In previous years the initiative was taken to design 'Course Letters' (Lesbrieven), to be distributed as major part in a newly established 'Buletin Pemodelan Matematika'. Just like in 2007 and 2008, also in 2009 no new bulletins appeared. In The Netherlands the contents of the course-letters was used as a start for the design of material for a new secondary school course 'Wiskunde D' on 'modelling'. It is a pity that we were up to now not able to advertise this, originally Indonesian initiative, to Indonesian secondary schools.

II. LMI-Research

LMI-Research consists for a part of strategic research that aims to develop the infrastructure to execute modelling and simulation activities in a specific application domain; design of high-level specific software may be part of that infrastructure.
LMI will actively initiate or participate in the application and the execution of scientific projects acquired from national or international organisations.
Contacts with companies or (governmental) institutions may lead to contract research projects or advisory activities in one of the application domains.
Associate scientist positions can be assigned to execute or supervise part of the research.
The description below starts with an identification of the research areas in which LMI will concentrate its activities in the foreseeable future. Then the specific projects are listed briefly; more details can be found in Annex I, and details about the research topics are described in a (separate) LMI Research PortFolio that is updated regularly (http://www.labmath-indonesia.org/ResearchPortFolio/).

II.1. Strategic Research Orientations (SRO)

All activities of LMI concentrate on mathematical modelling and simulation, motivated by its extreme usefulness in many areas of human activities, in technology and in the study and understanding of nature. Hence, the activities of LabMath-Indonesia are not restricted to a single field or discipline; the emphasis is to actively promote the use of methods and knowledge from the field of (mathematical) modelling and simulation.
In (strategic) research activities, we aim to contribute to the further development of such methods and knowledge. With the almost unlimited number of application areas, a focus for strategic research is required. The focus may change and develop with time.
In 2009 the activities on geo-mathematics have been actively pursued, both in further developing our own wave simulation codes as well as in management aspects of coastal zones. But also various aspects of environmental (rain) water were investigated, using simulation tools to predict flooding of rivers that may be caused by human or natural (climate change) interventions.

1. **Geo-Mathematics**

Under this title we assemble activities that have nature itself as topic of research.
Most of this research is carried out by LMI as the main initiator, with the staff of LMI in leading positions.
One topic of focus is on water waves, including coastal aspects which are so vital for Indonesia: flooding of cities, coastal erosion wiping away beaches, and effects of tsunamis on the coast. Environmental water, i.e. rain water and all that happens with it after having reached the earth, has been a topic of much interest this past year, and may stay so for a longer period to come.
In the longer run we aim to have efficient and reliable simulation tools coupled to data assimilation tools, such as online registration of wind, coastal waves, rainfall, evaporation etc, and a modern data base with a layered GI (geo-informatics) system that also includes land-use, human activities and social data.

In the year 2009 we worked on previously granted research projects in the area of surface waves and tsunami modelling and simulation. These projects are aimed to understand extreme water waves, to improve tsunami simulations and to make an inventory of research capacity in Integrated Coastal Zone management. Various major Indonesian university and governmental institutes are involved, together with the Dutch university group Applied Analysis & Mathematical Physics (AAMP) of the University of Twente. With several students we continued to develop the new Variational Boussinesq Model and code for tsunami simulations; various versions of this model are developed as the future tool for simulations in hydrodynamic laboratories and for coastal zone and tsunami simulations.
In 2009 we formulated 2 new research applications in the area of coastal wave modelling. In this topic, we aim to advance the mathematical modelling of the deterministic and the spectral wave modelling of waves near the coast. The proposals were approved for funding in 2010, which gives a guarantee that we can continue in this major LMI research topic.

2. **Engineering Mathematics**

If the natural sciences constitute the first area from which methods and ideas in mathematical modelling and simulation have been developed, then 'engineering' is certainly the second.
In the broad area of Engineering Mathematics we aim to remain involved in specific areas. However, in view of the necessity to concentrate the limited LMI resources and the choice for geo-mathematics as main application domain, we will restrict our efforts in this direction, and concentrate on providing high-quality research and service.
LMI was supportive for research executed under the Graduate Residency scheme, dealing with various problems from tribology.

II.2. Projects

a. The research in the Dutch NWO-AL project:
Nearshore tsunami modelling and simulations
that started in July 2008 with a PhD-position occupied by Wenny Kristina, continued in 2009; a short visit to LMI was part of the field work for the project.

b. The one-year CAPaBLE (Capacity Building) APN Project:
Integrating Indonesian Capacity for Coastal Zone Management
that started in September 2008 was continued in 2009. Most notable was the organization of the international Workshop on Oceanography and the Symposium on Coastal Zone Management in May 2009, together with the launching of a specially designed Coastal-HUB website. The project was finished successfully in mid 2009.

c. In 2009 the execution of the KNAW Mobility research project:
Aspects of Tsunami Simulations (07-MP-11),
a collaboration with a seismologist and tsunami-researcher of ITB, was continued with the successful Research Work Shop in January mentioned above in which the internship students who worked at LMI on various projects before the RWS gave a substantial contribution. The project finished successfully in mid 2009.

d. In 2009 a third small project for MARIN (Maritime Research Institute Netherlands) on
Inverse modelling for wave generation in hydrodynamic wave tanks
was executed. Like the previous two, the project showed the very good performance of the implementation of a new wave model, the AB equation – published in 2007 by Van Groesen & Andonowati-, and was the start of research on environmental waves (irregular waves as appear in the coastal zone).

e. The proposal, entitled
Indonesian Environmental Water Flux Modelling,
that was submitted at the end of 2008 in the WOTRO/KNAW priority area *'Agriculture beyond Food'* was not approved for funding, with the main argument that the proposal did not meet the main target of the call (use of agricultural products for non-food purposes), although our proposal was to ensure research to satisfy the basic water needs for agricultural production. Since a – much smaller - mobility project in this direction was granted (see below), at least some activities in this direction could be developed with some of the participating applicants.

f. A KNAW mobility project on environmental water, submitted in November 2008,
Modelling the total water balance in Indonesia (08-MP-04)
was approved and the execution started in May 2009. The project is a collaboration with UT Civil Engineering and UT Applied Mathematics, IPB Bogor and BMG Jakarta.

g. A 1-year mobility project to KNAW was submitted in September 2009
Accurate Coastal Wave Modelling and Simulation (09-MP-06)
jointly with ITB staff Prof. Dr. Safwan Hadi and Dr. Nining Sarih Ningshi; the project was approved in 2010.

h. A 2-year KNAW Post-Doc application for Dr. Wiwin Windupranata (part-time researcher at LMI) submitted in October 2009, entitled
High resolution time-dynamic wave simulations of Tanjung Priok Harbour, Jakarta (09-PD-05)
was also approved for execution to start at mid 2010.

II.3. LMI-internal Research

Part of the research executed by LMI (staff and resident-students) may not formally belong to an externally granted project, but will contribute to one of the SRO's, or prepares supportive facilities for future activities. In 2009, some previous research in the direction of *Mathematical Optics* (SRO-EngMath), and in the area of *High Performance Computing* was terminated.

II.4. Publications and Presentations

See Annex II.

III. LMI - Residency

Human resource development is supported by LMI in a practical way by contributing to the personal development of bright young students and the further development of senior scientists. To that end, LMI acts as host for young students, scientists and practitioners from Indonesia and abroad, thereby creating an inspiring scientific and international atmosphere.

Internships

Young Indonesian students can execute an Internship at LMI. This is a period of concentrated work on a specific subject. S1 and S2-students or graduates may work on their final project topic, or on a subject that is related to a previous RWS in which they participated and were chosen as one of the best participants. Also a period after graduation can be used as Internship to prepare for going abroad or for taking a job. During the Internships, the students get close supervision, and are trained in doing research, writing papers and giving presentations. If needed, also their English proficiency is improved.

In 2009, BSc graduates and MSc-students Gulit Widarta, Joko Prihantono, Elsa Melfiana, Nikenasih Binatari, Natalia and Winkausyar continued from 2008, and arriving in 2009 Anindya, Izza, Nadifa, Rachma and Aditia Rosali worked at LMI for a total period of 60 months.

International Student Visitorships

LMI stimulates international exchange by acting as host for students from abroad to execute a traineeship or (part of) a project at LMI. Also information is given to interested students from abroad about possibilities to execute such work at other places.

In 2009, three BSc students from UTwente working on environmental water (Erik Ensing, Ferdinand van den Brink and Joost Noordermeer), and one MSc student from TUDelft (Wander Wadman) working on spectral wave modelling, executed their practical traineeships at LMI for a total period of 11 months.

Graduate residency

PhD and Post-doc students can be associated to LMI to execute (part of) their work. This applies in particular when the PhD position is funded by an external (national or international) university institute where the degree will be awarded. In the case of non-university institutes and other organizations, an external supervisor will be involved to award the degree after finishing.

In the Joint PhD-construction between LMI and UT- Applied Mathematics, Didit Adytia continued his PhD project on Variational Boussinesq Simulations – that started in July 2008- with a visit to UTwente from February on for one full year.
In the construction with UT-Mechanical Engineering, the 2 PhD students on research in tribology continued their research at UNDIP, while one staff member of UNDIP continued his KNAW post-doc position.

IV. Internationalization

LabMath-Indonesia maintains and constantly extends contacts with Indonesian and international groups for programme activities and research. The contacts and activities make it possible to identify good young Indonesian students who want to go abroad and foreign students who want to visit Indonesia. These contacts and information about international degree-programmes and PhD positions are used to link capacity and demand from both sides.

- As part of the Internationalization activities, LMI provides services to students and staff and to universities to facilitate the bi-directional exchange of students between Indonesian and international universities and institutions. Matching of researchers for collaboration in international research projects is included.
- LMI acts as host since August 2007 of the official Indonesia Support Office for the University of Twente, Netherlands. This includes that LMI provides professional information about Master programmes and PhD positions for Indonesian students looking for continued education at UTwente. Active collaboration is sought with Indonesian universities for student exchange in both directions and collaboration in education and research.

V. Memberships

The aim to advocate the use of Mathematical modelling and Simulation includes the development of a network of Indonesian scientists who can interact with each other and with international partners.
This is made explicit in the Capacity Data Base under development, but also by attracting institutions and individuals as 'members' of LabMath-Indonesia.

VI. Facilities

a. Data-Lab in development

Data are crucial and will become only more important with increasing technology, services etc. It is the aim of LabMath-Indonesia to develop a data base with selected elements of scientific physical data as well of socio-economic data.
Research to transform these data into useful information, for government as well as for private enterprises, could be beneficial in many respects. As a first step in this direction, the technical infrastructure will be developed for physical data; collaborations with other groups and disciplines have been explored and will be developed further.
From the research in 2009 in some student projects on spectral wave modelling, wind data in the Indonesian region of the past 25 years have been collected and made ready for use to calculate wind driven water waves.

b. Capacity Data Base

A Capacity Data Base is under development that will eventually contain information about capacity and interests of scientific groups in Indonesia, and that can be used to match with international partners.
As part of the APN project, the capacity in the area of Coastal Zone Management has been collected and assembled in a separate data base.

c. Supporting Staff

A temporary part-time position supports technical and computer software matters.
Administrative staff has been appointed for secretarial and financial tasks. By sharing the work with similar work for other activities within Yayasan AB, it is possible to organise their total tasks in a most optimal way.

d. Housing: Lawangwangi

In 2009, the office at Anatomi was used for the Research Work Shop, and the Hotel Jayakarta for the international Workshop and Symposium.
As scheduled, in August 2009 LMI moved office from Anatomi 19 to the new Art & Science Estate called Lawangwangi. One large computer room, a staff room and a visitor room, together with rooms for supporting staff, are full-time available for the LabMath activities. For course activities, a large room with adjacent free spaces can be used as lecture room for up to 200 participants, and the large lounge is available for social gatherings, lunches and dinners.

VII. Personnel and Associate Scientists

Since its foundation, Dr. Andonowati acts as the Director of LabMath-Indonesia, and since January 2008 Prof. E. van Groesen acts as the Scientific Director.
Dr. Ardhasena Sopaheluwakan unexpectedly left LMI in April 2009.
To support research and supervision, 2 scientists were appointed at part-time positions:

Dr. Wiwin Windupranata (also at ITB, Bandung) for coastal waves,
Dr. (Dody) SK Saptomo (also at IPB, Bogor) for environmental water.

For the execution of projects of LabMath-Indonesia, junior and senior scientists can be appointed as associate scientist on a temporary basis with a specific purpose.
Appointments as senior scientists:
in 2007:

Dr. Wiratmaja Puja (ITB, Bandung)
Dr. Bekar Fajah TK (UNDIP, Semarang)
Dr. Jamari (UNDIP, Semarang)

in 2008:

Prof.dr. Sri Widiantoro, (ITB, Bandung)
Dr. Hamzah Latief (ITB, Bandung)
Dr. Ferry Permana (UNPAR, Bandung)
Dr. Ketut Wikantika (ITB, Bandung)

and newly appointed in 2009:

Prof.dr. Hidayat Pawitan (IPB, Bogor)

As junior scientists (working on PhD projects) are appointed:
in 2007

Rifky Ismail (UNDIP, Semarang)
Made Parwata (ITB, Bandung)

in 2008

M. Tauviqirahman (UNDIP, Semarang),
Didit Adytia (LMI).

VIII. Funding and subsidies

Until this moment there is no structural funding for the activities of LabMath-Indonesia.
Execution of substantial research activities is possible only if external funding can be obtained.
Additional support for the execution of Research Work Shops on Tsunami simulations was received from the University of Twente and Deltares, and the LMI-centre Christiaan Huygens.

IX. Outlook

In 2009 LabMath-Indonesia developed further to become a research institute that can promote and stimulate the use of Mathematical Modelling and Simulation in Indonesia. LabMath-Indonesia can link the increasingly many other areas and disciplines that use these methods to an ever increasing level of maturity and to new exciting developments in Applied Mathematics.
LabMath-Indonesia can play a role complementary to existing universities and governmental institutions, supporting new developments and interesting research problems for young Indonesian scientists in a flexible up-to-date scientific environment.
However, the lack of structural funding and the need to make the activities sustainable, led to the focussing of the main activities on problems from the natural sciences, in particular on coastal waters and environmental water.
Also in 2009 we received support from KNAW (Netherlands Academy of Arts and Sciences) by granting the mobility project; more and more visitors could be welcomed at the LabMath-office, partly for executing the RWS and the workshop/symposium.
Collaboration with UNPAD in 2007, UNPAR in 2008, and in 2009 with ITB and IPB in executing the course activities and research projects adds to the picture of a slowly expanding network.
The housing in the new Art & Science Estate Lawangwangi will make it possible to organise course activities at our own place in a very suitable environment.

Annex I: List of LMI projects

Below is a list of projects in SRO GeoMathematics in which LMI has been involved during the reporting period.

1. SRO GeoMathematics

1.1

Title	**Nearshore tsunami modelling and simulations**
Short description	This project aims to increase our understanding of various aspects of nearshore tsunami flows using analytical and simulation tools. In particular, we aim to significantly improve predictions of the large spatial variability of tsunami waveheights along the coast. Currently, wave height cannot be calculated accurately enough with the present-day simulation tools. Two major sources of inaccuracies will be investigated, and improvements in our numerical modelling will be validated in several case studies involving actual tsunami data. The first improvement concerns the characteristics of the waves that approach the nearshore region originating from the oceanic excitation region. To that end we will use and further develop a Variational Boussinesq Code (VBC) which fully accounts for dispersive effects and nonlinearity, while remaining computationally efficient. A second source of inaccuracies is caused by interaction of incoming waves with waves reflected from the coast. Computing the details of runup and run-down of waves on the coast is computationally very demanding, and the modelling of the physical processes is bound to be rather rudimentary. It causes, along with the use of (overly) simplified fixed wall boundary conditions, the inaccuracies in modelling reflected waves. By a detailed theoretical and numerical study of run-up and rundown characteristics of waves in their dependence on land topography and friction parameters, we will capture these boundary interactions in so-called parameterized effective boundary conditions (PEBCs) to be imposed at the shoreline. These boundary conditions are of general relevance and can be implemented in any numerical program to approximate the onshore tsunami flow without the necessity to calculate the detailed flooding and drying flows. We will implement the PEBCs in the VBC and consider several specific cases of tsunami propagation in the Indonesian coastal seas. One case will deal with nearshore tsunami waveguiding; this phenomenon may cause locally large enhancement of wave heights due to transversal shallower regions. The ability of our model to capture reflection properties, possibly leading to resonances in closed seas like the Flores Sea, will be investigated. Obliquely incoming and near-tangent flows will be encountered in simulations of tsunami flow through narrow straits and around islands; these case studies will concern the Bali-Lombok region. Finally, improved simulations of flows near the shore will facilitate the capability of structural engineering calculations of wave loading of natural and man-made structures in coastal regions, thus greatly facilitating better design tools for tsunami hazard mitigation measures.
Funding	NWO-AL (Netherlands), 1 PhD-student
Period	2008 – 2011
Participating groups	UTwente: Prof. E. van Groesen, Dr. O. Bokhove; Wenny Kristina LMI: Dr. Andonowati, Didit Adytia
Applicants / Supervisors	Prof. E. van Groesen

1.2

Title	**Integrating Indonesian Capacity for Coastal Zone Management**
Short description	In May 2007 waves of 5 to 7 meter high invaded the shoreline at the south-coast of Jawa, causing casualties and coastal settlements ruined. This exceptional event illustrates the impact on the coastal areas of bad weather conditions that are likely to become custom as an effect of Global Change. This project contributes to a better Management of Coastal Zones by building an Integrated Capacity from elements that

	are now isolated at Indonesian institutions. In 2008, after the project was granted, information for a data base started to be collected, and the first planned meeting took place. In 2009 the Indonesian capacity in coastal zone management was collected and information of many scientists and practitioners were collected in a public data base, www.IndonesianCoastalHUB.org, designed and maintained at LMI. From this inventory it was concluded in a second expert meeting that the Indonesian capacity in Coastal Zone management is still weakest in the area of coastal oceanography modelling. For that reason the concluding workshop meeting of the project concentrated on coastal oceanography, while the successive symposium brought more general aspects of coastal management to the front; see the description at the end of this report and www.labmath-indonesia.org/lectures for the lectures.
Funding	Capacity Building Project Asian Pacific Network (APN), CBA2008-08NSY-Andonowati
Period	1 August 2008 – July 2009
Participating groups	LMI: Dr. Andonowati, Dr. Sopaheluwakan ITB, Oceanography: Dr. N.S. Ningshi ITB, Civil Engineering: Dr. Iwan Hardaja BMG, Jakarta: Dr. Dodo Gunawan UTwente: Prof. E. van Groesen, Dr. G. van Vledder
Applicants / Supervisors	Dr. Andonowati

1.3

Title	**Aspects of Tsunami Simulations**
Short description	In a previous KNAW-Mobility Project, 05-MP-08 'Development of a Variational Boussinesq model for tsunami simulations', supported by a STW-project, basis elements of an accurate, robust tsunami model were developed and implemented in a code with Finite Elements. In a recently granted NWO-AL project, so-called Effective Land-Sea boundary conditions (ELSBc) are developed to be inserted in the code. In this Mobility Project, some further improvements and extensions of the code will be done as part of the following specific topics. The topics address important aspects that are not well studied yet. They are of direct relevance of tsunami-science in general and for the Indonesian situation in particular; the VBC will be a tool for these investigations. 1. Tsunami waveguiding. To explain the high variability of tsunami effects on the coast, the phenomenon of Near-coast Tsunami waveguiding has been discovered and published; in 05-MP-08 cases were simulated above synthetic bathymetry; in this project we will calculate cases above realistic Indonesian bathymetry. 2. Wave-generation from bottom excitations. The VBC can be easily extended to include precise bottom motions. Instead of using the most commonly used (Mansinha-Smylie 1972) method to take the bottom displacement (instantaneously) as initial water surface elevation, we will simulate the bottom displacement accurately. The research is directed towards the question if displacements above non-flat bottoms will give rise to much more energy input (side-wards directed) into the water than the MS-approximation would provide. If this is indeed the case –as is mentioned in some literature - this will have major effects on the tsunami- generation, and therefore on simulated wave heights. 3. Selection of tsunami scenarios. For an accurate simulation of tsunamis generated by tectonic plate motions, the precise position and character of the bottom motion is essential. This information is rather well known for previous cases, but prediction of possible future cases is difficult. Using tomographic methods, we will identify the most likely places which are close to tsunami-waveguiding prone areas. This will give input of realistic scenarios for tsunami simulations. The 5 internship students that were attracted to prepare the projects for the RWS, played a stimulating role during the actual execution of the projects in the RWS in January 2009.

Funding	KNAW Mobility Programme 07-M-b11
Period	1 August 2008 – September 2009
Participating groups	LMI: Dr. Andonowati ITB, Geophysical Group: Prof. dr. Sri Widiyantoro, ITB, Tsunami Research Group: Dr. H. Latief, UTwente: Prof. E. van Groesen, Dr. O. Bokhove
Applicants / Supervisors	Dr. Andonowati, Prof. E. van Groesen

1.4.

Title	**Modelling the Total Water Balance in Indonesia**
Short description	Indonesia faces various severe problems with water. Flooding of rivers in many areas causes great human, social and economic problems during the wet season. In the dry season, but also at several places in the wet season, there is a severe shortage of water for human consumption, industrial and agricultural use and natural vegetation. Various causes contribute to a worsening of the situation. One is the effect of Climate Change. Projections for South-East Asia show a median warming of 2.5 °C by the end of the 21st century with little seasonal variation (Christensen et al., 2007). Precipitation in South-East Asia is likely to increase for all seasons with a median value of 6-7 % and extreme precipitation events are expected to increase as well (Cruz et al., 2007). Other causes can be attributed to various human actions, such as changes in land-use for urbanization and industrialization, changes in the type of crop growth, deforestation, and changes caused by some of the engineering measures. All these changes can enhance flood and drought related problems. But the insight in the precise effects is still rather rudimentary and mainly qualitatively. The reason is that it is not easy to determine how and on which time scales water from precipitation influences discharges in rivers, ground water level etc. The aim of this programme is to investigate this aspect in a new way by designing a mathematical model that is complementary to models commonly used in Civil Engineering. The model we will design will be applicable on smaller areas as well as on larger areas such as river catchments or provinces. The model should make it possible to investigate, for instance, the effects of changes in the type of crop growth on the ground water level. Specifically, the increase of the ground water level if rice production - which requires on average 3000 litres water/kg- is changed into production of cassava - which requires 400 liters water/kg; this seems particularly interesting for Java, where at many places the decrease of the ground water level endangers the availability of water for direct human consumption and the environment. The model to be designed will address the interplay between the various components that constitute the total water balance on different spatial scales. This is the balance between, on the one hand, the total precipitation, and on the other hand the evaporation and transpiration (evapotranspiration), the overland runoff, the groundwater flow and the river discharge. An accurate quantification of all components seems impossible since data of river discharges and groundwater flows are poorly known. However, the mathematical model we will design will provide parameter dependent transfer functions between these components, so that changes in one component (such as increased rain intensity, or changes in crop type) will show the effects on the other components (such as ground water level). The validity of the model results will be tested against available field data. Even with approximate knowledge of the separate contributions to the water balance, the mathematical model is expected to be able to predict the effect of human and natural changes. Therefore, results of the project will contribute to understand some of the effects of Climate Change and change in agricultural productions, and may therefore become helpful for future management, policy and governance aimed at sustainable development of natural resources. In 2009 the participants contributed to the KNAW OSM and successive UT-ITC masterclass (see above). Dutch students executed practical trainee ships in the

	area of this project: hydrological modelling of the discharge of the Cidanau river in West Jawa, and calculation of evapotranspiration of Jawa. Besides that, one student started with data-extensive modelling of the drying of peatland, to see the effect of enhanced drying (and related extensive carbon emission) caused by drainage.
Funding	KNAW Mobility Programme 08-MP-04
Period	Submitted November 2008; execution started in May 2009, to be continued till mid 2010.
Participating groups	LMI: Dr. Andonowati Institut Pertanian Bogor(IPB): Prof.Dr. Hidayat Pawitan, Dr. SK Saptomo Meteorological and Geophysical Agency (BMG, Jakarta), Dr. Dodo Gunawan, UTwente: Dr. M.J. Booij, Prof. E. van Groesen
Applicants / Supervisors	Dr. Andonowati, Dr. Booij

1.5.

Title	**Accurate Coastal Wave Modelling and Simulation (application)**
Short description	Indonesia faces various severe problems with water. With the second largest coastline in the world, the coastal area is under large ecological pressure from pollution, over-exploitation and foreseeable effects of Climate Change, such as higher waves from stronger winds and nearby cyclones. For a sustainable development of the area, scientific tools should be used to observe the present state and to see effects of natural changes and human interventions. This project wants to further the development of a Variational Bousisnesq Model and its implementation as a scientific tool for coastal oceanography that can be used to support decisions about the coastal development. The Variational Boussineq Model (VBM) is a special variant of models that reduce the numerical calculations of surface water waves without the necessity to fully calculate the water motion below the surface. The model has been developed in collaboration between UT-AAMP and LabMath-Indonesia, with partial support from KNAW, in the past 4 years (see 1.3 above). Except from tsunami-simulations, the code is now being optimized for coastal zone applications, for which dispersive effects in the wind generated waves are much more important. This will be the main aim and the scientific challenge of the present project. We will investigate how to optimize the VBM in such a way that it is well capable to perform the task to deal correctly with the dispersion. The possibility to 'optimize' VBM can be taken literally, since the essence of VBM is that there is some freedom in the model, namely the choice that has to be made for the vertical fluid potential. To that end we take the profile to be dependent on the depth in such a way that it is exact for the linear mode that has an optimal wave length. This optimal wavelength is related according to the exact dispersion relation to the frequency (that is independent of depth in linear approximation) that minimizes the kinetic energy for the given initial spectrum of the wave field. To check the performance of the code we will benchmark the VBM results in various ways: comparison with data of MARIN-laboratory measurements, comparison with another Boussinesq model designed by Stelling, comparison with the commercial software MIKE21 [15-16]. For realistic simulations in the benchmarking of the time accurate codes described above, just as well as for realistic coastal zone applications, we need properties of the wavefield at the boundary of the numerical window. For that we can use the spectral wave fields that have been obtained at LabMath-Indonesia with spectral modelling, using Wavewatch III and SWAN software from wind data over the past 25 years. As specific applications, we will study extreme weather waves for harbour design and to investigate ship accidents.
Funding	KNAW Mobility Programme 09-MP-06
Period	Submitted November 2009 (approved March 2010).
Participating groups	LMI: Dr. Andonowati, Dr. W. Windupranata Institut Teknologi Bandung (ITB): Prof.Dr. Safwan Hadi, Dr. Nining Sarih Ningshi TUDelft: Prof.dr. G. Stelling

Applicants / Supervisors	UTwente: Prof. E. van Groesen Dr. Andonowati, Prof. E. van Groesen

1.7.

Title	**High resolution time-dynamic wave simulations of Tanjung Priok Harbour, Jakarta, Indonesia (application)**
Short description	As a largest archipelagic country in the world, about 140 million Indonesians live within 60 kilometres of the coast, many of these within the large coastal cities that occupy a predominant position in the national economy. At the same time, the coastal area is under large ecological pressure from pollution, over-exploitation and foreseeable effects of Climate Change. This project wants to develop scientific tools of coastal oceanography to support decisions about the coastal development. In particular, we will provide tools for the stakeholders dealing with harbour maintenance and development. This choice is motivated because harbours are essential for inter-islands transportation and for export-import infrastructure for goods. One important factor to be considered in the harbour maintenance and development is wave properties within the harbour, such as unwanted resonances, and in the surrounding area of the harbour. Besides that, analysis of wave properties is just as important for offshore structures, ship transportation as well as morphological changes. Unlike in many western countries, information about coastal waves is not directly available since direct measurements of waves are rare in Indonesia. Fortunately, with modern methods, properties of the (daily and most extreme) waves can be calculated from available wind data over a long past period. This so-called spectral modelling of wind-generated waves will be done in this project. The spectral simulations will be based on the 25-years of wind data and actual bathymetry. Average and extreme conditions of waves will be analyzed. These data are the basis of much more accurate, high spatial resolution and time-dynamic wave simulations, which will be done with a Variational Boussinesq Model, which has to be improved and extended in various directions. In order to test the tools to be developed, we will investigate in detail one specific test case, the Jakarta Bay and specifically the Tanjung Priok Harbour, which is the largest and most important harbour in Indonesia. Challenges to expand the harbour motivates to take this harbour as specific study case, and to apply and test the tools to be developed. To support the testing, wave measuring campaigns will be performed and compared to quality of the wave simulations.
Funding	KNAW Post-Doc Programme 09-PD-05
Period	Submitted October 2009 (approved March 2010)
Participating groups	LMI: Dr. Andonowati, Dr. Wiwin Windupranata (as Post-Doc) UTwente: Prof. E. van Groesen
Applicants / Supervisors	Dr. Andonowati, Prof. van Groesen

Annex II: Publications and Presentations

Below publications and presentations are listed of research that has been executed at LabMath-Indonesia or in close collaboration with LMI.
For similar information in the years 2005-2008, see the Yearly Reports 2007 and 2008.

II.1 Publications (in 2009)

- D. Adytia & E. van Groesen,
  Variational Boussinesq model for simulations of coastal waves and tsunamis,
  Proceedings of the *5th International Conference on Asian Pacific Coasts*, (APAC2009) 13-16 October 2009 Singapore 9ed: Soon Keat Tan, Zhenhua Huang]; World Scientific 2010, ISBN-13 978-981-4287-94-4, Volume 1 (ISBN-13 978-981-4287-96-8), pages: 122-128.
- L. She Liam & E. van Groesen,
  Variational derivation of KP-type equations,
  Physics Letters A, **374**(2010) 411-415, doi:10.1016/j.physleta.2009.11.016
- N. Karjanto & E. van Groesen,
  Qualitative comparisons of experimental results on deterministic freak wave generation based on modulational instability,
  Journal of Hydro-environment Research **3**(2010) 186-192, doi:10.1016/j.jher.2009.10.008 (online 23 October 2009)
- E. van Groesen, Andonowati, L. She Liam & I. Lakhturov,
  Accurate modelling of uni-directional surface waves,
  Journal of Computational and Applied Mathematics 234 (2010) 1747-1756 (2009, doi:10.1016/j.cam.2009.08024, online: 19 august 2009)

II.2 Presentations (in 2009)

- Chris Mannaerts, *Use of earth observation and in situ data for enhanced forecasting and decision making in water management*
  (18-11-2009) KNAW-Open Science Meeting, UT-ITC masterclass Water Research and Management
- Martijn Booij, *Hydrological modelling in Pakistan and Iran: glaciers and evapotranspiration*
  (19-11-2009) KNAW-Open Science Meeting, UT-ITC masterclass Water Research and Management
- Hidayat Pawitan, *Water Management Issues and Technology Needs in Indonesia*
  (20-11-2009) KNAW-Open Science Meeting, UT-ITC masterclass Water Research and Management
- Andonowati, *Modelling and simulation of tsunamis, coastal waves and extreme waves*
  (20-11-2009) KNAW-Open Science Meeting, UT-ITC masterclass Water Research and Management
- Rik Bulsink, *The water footprint of Indonesian provinces related to the consumption of crop products*
  (Practical traineeship at LMI) (20-11-2009) 'UT-ITC Master Class Water Research and Management'
- Ferdinand van den Brink: *Modelling the discharge of the Cidanau watershed with the HBV model*
  (Practical traineeship at LMI) (20-11-2009) 'UT-ITC Master Class Water Research and Management', 18-20 November 2009
- E. van Groesen, *Variational Boussinesq modelling for simulations of coastal waves and tsunamis*
  (13-10-2009) 5th International Conference on Asian Pacific Coasts, (APAC2009) 13-16 October 2009 Singapore
- E. van Groesen, *Variational Boussinesq modelling of harbour waves*
  (20-05-2009) International Symposium Effects of Climate Change on Coastal Zone Management, 18-20 May, Bandung Indonesia
- E. van Groesen, *Deterministic wave modelling and simulation*
  (17-05-2009) International Workshop Coastal Oceanography: waves, currents, tides & tsunami, 16-17 May, Bandung Indonesia
- E. van Groesen & Andonowati, *Modelling in the Natural Sciences*,
  (06-05-2009) Key-note lecture ICONES 2009 (International Conference on Natural and Environmental Sciences) Banda Aceh 6-8 May 2009
- D. Adytia, W. Kristina and E. van Groesen, *Tsunami Waveguiding Simulation Above Synthetic and Realistic Bathymetries,*
  Poster, European Geosciences Union General Assembly 2009 Vienna, Austria, 19 – 24 April 2009

GeoMath

TSUNAMI MODELING AND SIMULATIONS

12 – 23 January 2009, Bandung

Organised by

Laboratorium Matematika Indonesia
(LabMath-Indonesia)
www.labmath-indonesia.or.id

in collaboration with

- Institut Teknologi Bandung, and
- University of Twente, the Netherlands

This activity is a part of KNAW Mobility Programme 07-MP-11
(Royal Netherlands Academy of Arts and Sciences)

AIM AND DESCRIPTION

Scientists have already a good qualitative view what happens when a land plate suddenly slides over an ocean plate and thereby brings the water above the moving bottom into motion and excites a tsunami. On its way to the coast, the tsunami conserves energy and its amplitude increases when entering the shallower coastal areas. We have seen dramatic effects on the coast when the tsunami runs over land.
Scientists have made models to translate the qualitative ideas into models and simulations to get quantitative results; many 'tsunami codes' exist. Amazingly, when simulation results are compared with field-observations on the coast, it turns out that often the simulations of wave heights are a factor two or three wrong. We will address several aspects that may lead to errors in the simulations because the modelling is too complicated and not yet well-understood. We will discuss, and make projects, on the following aspects.
One topic will be the evolution of water waves, from basic properties such as wavelength and amplitude dependence on depth, to more advanced aspects of inverse modelling to estimate the initial tsunami waveform from measurements at buoys.
Another topic will be the wave excitation process: the basic principles and the more difficult modelling of the tectonic plate motion, and the translation of bottom motions into tsunami properties such as initial waveform.
One topic will deal with the complicated overland flow when the tsunami reaches the coast; we investigate how details of vegetation and buildings influence the run-up (inundation) height.
Although this tsunami topic from geo-science is interesting and relevant in itself, the RWS may be very valuable for participants with different background, because the methods from applied mathematics and the modelling experience are useful for many other areas in science and technology as well.
In this RWS we aim at a stimulating atmosphere where participants from several disciplines will work together. Except the lecturers, we will also have young students who will contribute to the exercise periods and to the projects. They have been working for some time as junior researcher with an internship at LabMath-Indonesia on (related) topics to support the research in the KNAW Mobility Programme.

LECTURERS

Prof. Dr. Sri Widiyantoro, Institut Teknologi Bandung
Dr. Hamzah Latief, Institut Teknologi Bandung
Dr. Deepak Vatvani, TUDelft and Deltares, Netherlands
Didit Adytia MSc, LabMath-Indonesia & UTwente
Prof. Dr. E. Brenny van Groesen, University of Twente, the Netherlands

PROJECTS

Below we list the titles and a short description of the project topics.

Project 1 : **TSUNAMI CODES**

The aim is to design and implement a simple tsunami code in 1D above synthetic bathymetry to illustrate the basic properties of amplitude and wavelength changes with changes in depth, and to select well defined conditions (tsunami generation scenario, physical domain and bathymetry) such that tsunami excitation and wave development till close to the shore can be simulated. We will be interested in the effects on the near-by coasts.

Project 2 : **WAVE GENERATION BY BOTTOM EXCITATION**

If we lift part of the bottom below a layer of fluid, the incompressibility of water will give rise to disturbance of the initially still free water surface. The aim of this project is to find out what the influence is of the bottom excitation on the generated waves.

Project 3 : **INVERSE TSUNAMI MODELING AND SIMULATIONS**

Given data consisting of time signals of surface elevation as measured by buoys at one or more positions, determine as much as possible information about the tsunami excitation process: the bottom profile displacement and the dynamics of the bottom, with the aim to characterise the tectonic plate motions (shape and dynamics).

Project 4 : **BOTTOM EXCITATION FROM SEISMIC DATA**

Another way to extract information about the tsunami excitation process could be to find as good as possible a characterization of the tectonic plate motions (shape, displacement and dynamics) from seismic data. In several stages of complication, we want to develop better insight in the generation process.

Project 5 : TSUNAMI WAVE AND INUNDATION HEIGHT ON LAND

This project investigates the tsunami when it has reached the land, centred around the question what the inundation height will be, and most important, how this height depends on the depth gradient of the ocean bottom, and on vegetation (mangroves) and defence measures on the land.

VENUE

LabMath-Office at Jl. Anatomi 19, Bandung

International WORKSHOP
16 -17 May 2009
Coastal oceanography: waves, currents, tides & tsunami

Bandung , Indonesia
Hotel Jayakarta

CBA2008-08NSY-Andonowati
Integrating Indonesian Capacity for Coastal Zone Management

The topic of the workshop was decided during the second meeting of the APN-project based on the opinions of the participants of that meeting and the outcomes of the data-base investigation till that time. The workshop addressed a weak spot in the Indonesian Coastal Zone management, and coastal oceanography is part of that.

The workshop addressed various topics in an instructional way, without losing the perspective of the total environmental aspects.
At www.labmath-indonesia.org/lectures all ppt's of the lectures can be downloaded.
Here we give a short characterization of the contents of the lectures.

Hamzah Latief,
Tsunami Modelling and their Mitigation
General and more technical aspects of tsunami simulations, with emphasis on effects on the coast, were discussed. Calculation of coastal risk, and description of protective measures, including alternatives for the international Tsunami early warning systems.

Andi Jamaluddin and Samudro,
Impacts of environmental loads on safe sea transportation
This lecture directly discussed the expected effects of Climate Change on the safety of ship transportation. Higher wave are to be expected, and the (already many) ship accidents caused by bad weather may be expected to increase; proposal for further investigations.

Indra Jaya,
Coastal Current: Generation, Measurement and Its Effect on Coastline and Coastal Fisheries
The importance of currents was discussed: currents in the direction along the shoreline give rise to sedimentation transport and shoreline changes, and currents caused by wind from or to the land give up- or down-welling, affecting fisheries. Effects of CC were discussed.

Poerbandono,
Spatial approach in watershed and coastal studies
The lecture addressed the usefulness of a spatial approach towards problems at the coastal zone, and gave also example for problems with rivers (STREAM-software).

Safwan Hadi,
Simulation of Impact of Storm Surges Vulnerable Area along Southern Coast Of Java Caused by Cyclones Jacob and George in March 2007
The cyclones mentioned in the title occurred in the north-western part of Australia, but the winds very strongly affected the Indonesian Jawa coast; such cyclones are expected to become more frequent as an effect of CC.
Simulation tools were discussed that are capable to predict the waves affecting the coasts form the given meteorological data (wind speeds); this opens the opportunity to wave predictions/warnings from weather predictions.

Gerbrant van Vledder,
Spectral wave modelling in coastal waters
This lecture addressed the methods that are nowadays used in modern software (WaveWatch and SWAN) to calculate the generation of waves by wind. Although the details are rather complicated, the overview and the differences between deep and shallow waters were explained clearly.

Brenny van Groesen,
Deterministic wave modelling and simulation
The actual evolution of waves in a dynamic way – different from spectral properties in the preceding lecture- requires different, equally complicated software if sufficient accuracy is desired; the example of waves in a harbour illustrated the complicated effect of resonance.

International SYMPOSIUM
18 - 20 May 2009

Effects of Climate Change On Coastal Zone Management

Launching of **Expert Capacity Data Base**
IndonesianCoastalHUB

Bandung , Indonesia
Hotel Jayakarta

APN CAPaBLE

CBA2008-08NSY-Andonowati
Integrating Indonesian Capacity for Coastal Zone Management

LABMATH INDONESIA

The 3-day symposium, different than the preceding workshop, addressed many different aspects of Effects of Climate Change on Coastal Zone Management. This is shown from the titles of the various lectures (lectures can be downloaded from www.labmath-indonesia.org/lectures):

Luky Adrianto,
The social-ecological system approach in the context of integrated coastal management and governance

Jamaluddin Jompa,
Climate Change, Potential Impacts on Coral Reefs, and Management Challenges

Hamzah Latief,
Coastal Zone Research

Dietriech G. Bengen,
Climate change and global warming: implication to coastal zone and small islands, and strategic perspective of adaptation

John I. Pariwono,
Ramification of sea level rise on sea-border between neighbouring countries

M.M. Julian, Poerbandono and P.J. Ward,
The role of precipitation, temperature, and land cover in controlling run-off of the northwest of Java coastal zones: a climate change perspective

T. Ferijal and Patricia K. Smith,
Freshwater inflows modeling using SWAT

Gerbrant van Vledder,
Wave modelling in a tidal inlet system

YAB Labmath,
Indonesian Water Balance and Waterfootprint

Kadarsah,
District Level Prediction for Assessment of the Impact of Climate Change on Coastal Management

Budianto Ontowirjo,
Hydrodynamics and sediment transport modelling for softshore protection in ICZM

W.Windupranata and I.Hayatiningsih,
Past-decadal simulations on ocean waves, tides, currents and sea surface temperatures on the northern coast of West Java

Dewayany Sutrisno,
Spatial assessment modeling for the impact of climate change on coastal management

Agus Salim,
The study of ecological risk assessment of oil spill in Jakarta bay water

Y.R.A. Lumingkewas, R. Poerbandono and K. Prijatna,
Recent adaptation measures and the progressing regional environmental settings in Seribu Islands, Java sea, Indonesia

Brenny van Groesen and Didit Adytia,
Variational Boussinesq Simulations of harbour waves

Edvin Aldrian,
Carbon nutrient coastal fluxes over Java and the possible impacts to global climatic changes

Jonson Lumban Gaol,
Impact of climate change on phytoplankton chlorophyll in Indonesian waters

Ricky Rositasari, Suyarso, Afdal, Suratno and Bayu Prayuda,
The impact of climate change to several aspects of coastal system

During the symposium, also the website with database www.IndonesianCoastalHUB.org was officially launched by Dr. Andonowati, the project leader, together with an explanation of the contents. The discussion addressed especially safety and maintenance aspects as critical points to make the database trustworthy and sustainable for the future.