

Yearly Report 2010

Lab **Math** - Indonesia

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Introduction

Since the foundation of **LabMath-Indonesia** at 1st June 2005, this is the fifth annual report, covering the year 2010.

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 2010 to fulfil the mission and to show the results of the ambition.

In most sections, small italic text describes the main underlying ideas, while the regular text concentrates on the 2010 activities.

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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 2010, a Short Course *GeonetCast* and a Training and Research Workshop *Satellite Based Water Balance Computation and Modelling* were organized, as described below.

I.1. Course GeonetCast and Modelling Workshop

Short Course *GeonetCast* 28 - 29 June 2010, and Training and Research Workshop *Satellite Based Water Balance Computation and Modelling* 30 June - 4 July 2010.

Data of environmental parameters are in many cases poorly available in Indonesia, especially data such as rainfall and (much more difficult to measure or model) evapotranspiration, while they are very important for environmental and agricultural policy and management. The motivation of the KNAW-Mobility project 08-MP-04 on Water Balance Modelling led to the idea to use modern technology to help to overcome this data-problem. In good collaboration with ITC, it became clear that satellite data would soon become available in Indonesia: data of the FengYun satellite through the Chinese Meteorological Agency. This possibility was the basis of the organization of the Course and Workshop: the course to introduce efficient software to translate satellite information to (environmental) data and the workshop to go into more detail about the modelling that is behind the data, which has to be critically examined and compared with in-situ data.

Lecturers for the course were: Dr. Chris Mannaerts and Dr. Tom Rientjes, UT-ITC, and for the workshop in addition Prof. Hidayat Pawitan and Dr. SK Saptmo (IPB), Dr. Martijn Booij and Prof Brenny van Groesen UT.

The relevance of the topic, not only from a scientific point of view but also for practical use by central and local governmental institutions, attracted much interest; in total 50 participants for the course and 31 for the training workshop could be accommodated: 15/10 from governmental institutions and ministries, 12/7 staff from universities and 23/14 students.

(see for full report the website: www.labmath-indonesia.org/events).

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 2010 the activities on geo-mathematics have been actively pursued, both in further developing our own wave simulation codes, as well as in environmental water.

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 2010 we continued and finished the KNAW mobility project *Modelling the total water balance in Indonesia*; the Course and Workshop described above in I.1 was part of the activities in that project.

We started the work on 2 newly granted research projects in the area of *surface waves and coastal wave modelling*: a KNAW post-doc project and a KNAW Mobility project. Since these projects are in line with previous projects supported by KNAW on wave modelling, it is worth to mention the following.

To test the performance of numerical codes, it is world-wide common to compare the simulations with data of real life measurements from experiments of hydrodynamic laboratories like MARIN (Wageningen Netherlands). A benchmark meeting was organized by MARIN in November 2010; except UT-LMI, there were 6 other participating groups, each with their own code. Comparison of the (blind) MARIN data with the various simulations, led to the result that ***the VBM and the AB-codes that were developed for a major part at LMI were the best performing codes***, and the only codes that could perform the simulations of wind waves above varying bottom.

A better motivation to continue this work at LMI is hardly possible.

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 KNAW mobility project on environmental water, submitted in November 2008, *Modelling the total water balance in Indonesia (08-MP-04)*, started in May 2009 and finished in September 2010. The project is a collaboration with UT Civil Engineering and UT Applied Mathematics, IPB Bogor and BMG Jakarta.
- b. A 1-year mobility project to KNAW, submitted in September 2009 started in summer 2010: *Accurate Coastal Wave Modelling and Simulation (09-MP-06)*
The project is executed jointly with ITB staff-members Prof. Dr. Safwan Hadi and Dr. Nining Sarih Ningshi.
- c. The 2-year KNAW Post-Doc application for Dr. Wiwin Windupranata (part-time researcher at LMI) started August 2010:
High resolution time-dynamic wave simulations of Tanjung Priok Harbour, Jakarta (09-PD-05)

II.3. 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 2010, BSc graduates Aditia Rosali, Achmad Zaky, Dwi Fajar Saputri, Meirita Ramdhani and Meli Fitriani worked at LMI for a total period of 32 months; Didit Adytia as UT-LMI PhD worked for 11 months at LMI.

▶ 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 2010, two BSc students from UTwente working on environmental water (Joost Noordermeer and Frank Meins), and a BSc student from RUWageningen (Marianne Tijds) executed their BSc thesis and practical traineeships at LMI for a total period of 5 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- at LMI after arriving in February from a visit to UTwente 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.

▶ Visitors

In 2010 Gert Klopman visited LMI for a period of 2 months to finish (with a successful defence in May 2010) his thesis on VBM.

Dr Natanale Karyanto, and UT-PhD student A Latifah visited LMI for a short time. The lecturers of the Course and Workshop in June/July stayed at LMI for the time of the course-workshop.

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.*

▶ Also in 2010 LMI acted 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 and Capacity Data Base

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. 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.

b. Supporting Staff

A temporary part-time position supports technical and computer software matters. Administrative staff for secretarial and financial tasks is shared within Yayasan AB.

c. Lawangwangi

Since August 2009 LMI has its offices in Lawangwangi Art & Science Estate. 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.

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)

in 2009:

Prof.dr. Hidayat Pawitan (IPB, Bogor)

and newly appointed in 2010:

Prof. Safwan Hadi (ITB, Bandung)
Dr. Nining Sari Ningsih (ITB Bandung)

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

For the execution of the summer Course and Work Shop travel costs of one UT-ITC lecturer was provided by UT-ICT.

IX. Outlook

LabMath-Indonesia as a research institute should develop further to promote and stimulate the use of Mathematical Modelling and Simulation in Indonesia, linking 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 should 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.

In 2010 the research was focussed on the main areas of coastal waters and environmental water.

As in many years before, also in 2010 we received support from KNAW (Netherlands Academy of Arts and Sciences) by granting one Post-Doc and one mobility project.

The execution of the course and workshop made the LMI network stronger.

The very rewarding result in the MARIN Benchmark competition stimulates the continuation of designing new software codes in Indonesia, eventhough the underlying motivation is to stimulate critical thinking in using *any* software.

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	<p>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.</p> <p>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.</p> <p>A second source of inaccuracies is caused by interaction of incoming waves with waves reflected from the coast. 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 the boundary interactions in so-called parameterized effective boundary conditions (PEBCs) to be imposed at the shoreline.</p> <p>In 2010 the project was largely executed at UTwente by the PhD student Wenny Kristina.</p>
Funding Period	NWO-AL (Netherlands), 1 PhD-student 2008 - 2011
Participating groups	UTwente: Prof. E. van Groesen, Dr. O. Bokhove; Wenny Kristina
Applicants / Supervisors	LMI: Dr. Andonowati, Didit Adytia Prof. E. van Groesen

1.2.

Title	Modelling the Total Water Balance in Indonesia
Short description	<p>The project has been executed as described in the proposal as a one year-programme on Total Water Balance organised by LabMath-Indonesia.</p> <p>We briefly describe the main activities:</p> <ul style="list-style-type: none">□ The Indonesian researchers visited the Netherlands; for part of the time they participated in the KNAW Open Science Meeting (16-17 November 2009) and in the successive KNAW-UT organized UT-ITC Master Class Water Research And Management', 18-20 November 2009.□ The Indonesian and Dutch researchers supervised five internship positions that were executed at LabMath-Indonesia.□ A successful 2-day Short Course and successive 5 day Training & Research Workshop were organized in June-July 2010, with 50 and 30 participants respectively; roughly half of the participants were staff from Indonesian universities and governmental organizations (Ministry of Marine and Fishery, LAPAN and PusAir), the other half were young students.□ Two staff members of UT-ITC, Dr. Mannaerts and Rientjes, lectured during the Short Course; they were also involved in the Training and Research WorkShop as supervisor, together with the members of the KNAW project.□ During the project period, the research concentrated on two topics<ul style="list-style-type: none">o hydrological modelling of a river catchment, ando research on math modelling of peatland drying and scenarios for rewetting.

Funding Period	KNAW Mobility Programme 08-MP-04 Submitted November 2008; execution started in May 2009, finished September 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

1.3.

Title

Short description

Accurate Coastal Wave Modelling and Simulation

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 Boussinesq Model and its implementation as a scientific tool for coastal oceanography that can be used to support decisions about the coastal development.

The Variational Boussinesq 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 Period	KNAW Mobility Programme 09-MP-06 Submitted November 2009, approved March 2010, started Summer 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 UTwente: Prof. E. van Groesen
Applicants / Supervisors	Dr. Andonowati, Prof. E. van Groesen

1.4.

Title

PostDoc-project: High resolution time-dynamic wave simulations of Tanjung Priok Harbour, Jakarta, Indonesia

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
Period
Participating
groups
Applicants /
Supervisors

KNAW Post-Doc Programme 09-PD-05
Submitted October 2009, approved March 2010, start August 2010
LMI: Dr. Andonowati, Dr. Wiwin Windupranata (as Post-Doc)
UTwente: Prof. E. van Groesen
Dr. Andonowati, Prof. van Groesen

Annex II: Publications and Presentations

Below publications and presentations in 2010 are listed of research that has been executed at LabMath-Indonesia or in close collaboration with LMI.

II.1 Publications (in 2010)

- 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,
- 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,
- 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
- Gert Klopman, Brenny van Groesen, Maarten W. Dingemans, A variational approach to Boussinesq modelling of fully non-linear water waves, *Journal Fluid Mechanics* **657** (2010) 36-63

II.2 Presentations (in 2010)

- E. van Groesen, *MARIN Benchmark simulations with ABvar and Optimised VBM (24-11-2010)* MARIN, Wageningen
- E. van Groesen, *AB and VB Models for coastal wave simulations (28-05-2010)* Deltares Seminar, Delft
- E. van Groesen & D. Adytia, *Hawaii-simulations with ABvar and Optimised VBM (22-04-2010)* MARIN, Wageningen
- Contributions to MARIN Benchmark meeting November 2010:
 - A. Latifah : simulations with AB-code of waves above flat bottom
 - E. van Groesen (D. Adytia): OVBM-simulations of waves above sloping bottom,
 - I van der Kroon, AB-simulations of waves above sloping bottom.