

Yearly Report 2007

LabMath-Indonesia

Date: 15 January 2008



Laboratorium Matematika Indonesia (LabMath-Indonesia) is an independent non-commercial research institute aimed to facilitate the execution of scientific research and to disseminate the results to the community.

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Yearly Report 2007

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Introduction

After the first report of **LabMath-Indonesia** that covered the period since the foundation at 1st June 2005 by Andonowati and E. (Brenny) van Groesen till the end of 2006, this report covers the year 2007.

The mission and ambition of LMI are shortly described as follows.

Mission

LabMath-Indonesia is an independent non-commercial 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, founded 1 June 2005 by Dr. B. Kartasasmita and Prof.dr. E. van Groesen, 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 2007 to fulfil the mission and to show the results of the ambition.



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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 2007, two **Research Work Shops** were organised. Each one 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.

One intense **SRO-Workshop** of two months was organised for close collaboration between senior scientists and young students (BSc-MSc and PhD) from Indonesia and The Netherlands.

We describe these activities briefly below.

I.1. Research Workshop

15 - 26 January 2007, 1 week Courses and 1 week Projects (SRO: GeoMath)

Inverse Modelling In The Natural Sciences

The general mathematical method of inverse modelling was illustrated with problems from various disciplines. Lecturers came from Indonesia (Dr. Sri Widiyantoro and Dr. Wahyu Triyoso, Institut Teknologi Bandung), Germany (Dr. Eifu Taguchi, AWI Bremerhaven) and the Netherlands (Dr. Remus Hanea, Univ. of Delft). In total 32 people participants came from 12 institutes and 7 disciplines; see Annex I for the announcement.

I.2. Research Workshop

6-16 August 2007, 1 week Courses and 1 week Projects

Operations Research and Optimization Modelling: Methodology, algorithms and applications

This RWS was executed in collaboration with UNPAD. Lecturers were from Indonesia (Dr. ir. Amril Aman, M.Sc., Institut Pertanian Bogor and Dr. Diah Chaerani, M.Si., Universitas Padjadjaran, Bandung) and The Netherlands (Dr. Sjoerd Baas, University of Twente). In total there were 35 participants from 15 different institutions covering 4 disciplines; see Annex I for the announcement.

I.3. Internal SRO-Workshop

1 August - 30 September 2007

Variational Boussinesq Modelling and Simulation

The Workshop was the starting point to design a Finite Element implementation of the Variational Boussinesq Model. Senior staff of LMI worked with 2 Indonesian students and 2 students from UTwente. Part of the results, dealing with tsunami simulations, were presented at the Open Science Meeting organised by RISTEK and KNAW in Bali, 18-20 November 2007. Results of this internal SRO-Workshop were also presented in the 1st LMI Colloquium held on the 19th of September, at the office of Labmath-Indonesia.

I.4. 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'. In this reporting period no new bulletins appeared.

In the table below, the main information is collected.

Buletin Pemodelan Matematika

Number and title of math-topic in 'course letter'.	Volume 1, No 1 , September 2005, <i>Wind waves and Tsunamis I</i> by G. Jeurnink & E. van Groesen, UTwente Volume 1, No 2 , January 2006, <i>Coding theory: the mathematics of error correcting</i> by D. H. Ster, TU/Eindhoven Volume 1, No 3 , June 2006, <i>Wind waves and Tsunamis II</i> by Dr. G. Jeurnink & E. van Groesen Volume 1, No 4 , September 2006, <i>Coding theory: the mathematics of error correcting (cont'd)</i> by D. H. Ster
Short description	Bulletin for secondary schools, containing 'Lesbrief' / 'Course Letter' with the topics mentioned above. The bulletin is distributed freely.
Funding	Yayasan AB
Period	Started September 2005 - continued
Participating groups	Collaboration with AAMP-UTwente, various authors in Indonesia and Netherlands
Editorial Board	Dr. Rinovia Simanjuntak (ITB), Dr. Jeurnink (UTwente), Dr. Wono Setyabudhi (ITB), Dr. Andonowati (LMI), Prof. dr. E. van Groesen (LMI).

I.5. Other activities

Some other activities in which staff or students from LMI were actively involved are listed below.

- a. Activities of LMI were clearly exposed in the booklet composed by KNAW entitled *Scientific Programme Indonesia-Netherlands: A Shared Passion for Research* (ISBN: 978-90-6984-539-5). Both in the interview part of the booklet, as well as in the scientific contributions, LMI was present.
- b. During the Open Science Meeting at Bali 18-20 November 2007, LMI illustrated the philosophy of working with young students. The MSc-student Didit Adytia and the BSc-graduate Laurentius Oscar Osaputra showed in a vivid 'laptop-presentation' some examples of their tsunami simulations that were a result of the work at LMI for three months. Both students were in one of the previous LMI-RWSs selected as (belonging to) the best participants.
- c. With Ms. Wenny Kristina we are preparing extensive Lecture Notes (to be published) related to the RWS of January 2007 'Inverse Modelling'.

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 project are listed briefly; more details can be found in Annex II, and details about the research topics are described in the (separate) LMI Research PortFolio.

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; the past period activities have been concentrated on the following areas which are chosen as strategic research orientations that will be developed further.

1. Geo-Mathematics

Under this title we assemble activities that have nature itself as topic of research. Especially we focus on water waves, and on coastal aspects which are so vital for Indonesia: flooding of cities, coastal erosion wiping away beaches, and effects of tsunamis on the coast. In the longer run we aim to have efficient and reliable simulation tools coupled to a modern data base with a layered GI (geo-informatics) system that also includes land-use, human activities and social data.

In the year 2007 we formulated 4 research applications in the area of surface waves and tsunami modelling and simulation; two were granted, and two are still waiting a decision. 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, and a Dutch university group.

A smaller project was executed to search the Indonesian coast for tsunami waveguiding areas. 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.

2. Engineering Math for Technology

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 Technology we will aim to be involved in specific areas. One of them is 'optics', and more generally 'nanotechnology' for future generation information and telecommunication technology.

The use of optical fiber as an information highway, transmitting information over long range distances provides fast and reliable means for information transmission. In the intermediate processing nodes and also at the end (users) nodes, information processing based on electrical devices has to be reduced as much as possible. All optical processing is much desired, with the aim towards an overall bottleneck free superfast information system.

Photonic Integrated Circuits are devices that integrate multiple photonic functions and as such are analogous to an Electronic Integrated Circuit. Embedded in this circuit are individual discrete building blocks; individual optical devices that have its own specific functionality that together builds the circuit.

The task of designing the optical devices brings forward the importance of mathematical modeling and numerical simulation. Having this ability will reduce the high cost of experimental work in clean rooms. Using modern advanced simulation techniques, technical restrictions that exist in Indonesia on experimental and production facilities, may partly be reduced.

3. Operations Research and Optimization Modelling

Decision support in certain and uncertain situations can be provided by modern methods from deterministic and stochastic operations research and (robust) optimization modelling. These methodologies can be very useful for many aspects of the Indonesian society, in government, industry and for many societal aspects.

Modern math-based software makes it possible to tackle complicated problems with high dimensional models.

There is a serious lack of high-level mathematical input in the areas where these methods are already used (like industrial engineering and decision support of any kind). LabMath-Indonesia will strongly promote and contribute to the development of this area in the near future; several contacts with industry in the reporting period support the necessity of further dissemination.

In 2007 we organised a RWS on this topic, and got contacts with an advisory company in this area (*New Frontier Solution*); research under the umbrella of LMI has not yet started.

II.2. Projects

- a. LMI played a leading role in the initiation and formulation of a Mobility project granted by the KNAW (Royal Netherlands Academy of Arts and Sciences, Netherlands) in December 2005:

Development of a Variational Boussinesq Model for tsunami simulations

This project is a collaboration between University of Twente and ITB (applicants), and the University of Brawijaya Malang. The project was finished successfully in 2007.

- b. LMI played a leading role in the initiation and formulation of a project submitted to RISTEK (Insentif Riset Dasar) and approved for execution:
Extreme Water Wave Modeling: Toward Safety of Sea Transportation
This project is a collaboration with P2MS-ITB (applicant) and University of Twente. The execution will start April 2008.
- c. A small one-year UTwente-project was executed at LMI:
Tsunami WaveGuiding in Indonesian coastal areas
The work in this project was the basis of the formulation of the NWO-AL application mentioned below (d); the successful execution leads to a continued one-year project to be executed in 2008. The projects are executed by students who were selected as best participants in previous LMI-Research WorkShops.
- d. LMI-research was the motivation to formulate a research project for a Dutch NWO-AL project:
Nearshore tsunami modelling and simulations
The project has been granted; the execution will start in August 2008 with the PhD-position occupied by a student who was selected to be the best participant in two previous LMI-Research Work Shops.
- e. LMI formulated a CAPaBLE (Capacity Building) APN Project:
Integrating Indonesian Capacity for Coastal Zone Management
The project passed the preliminary Stage 1 selection; the full proposal (Stage 2) has been submitted and is still under review.
- f. Ongoing LMI-research on tsunamis was the motivation to formulate a KNAW Mobility research project:
Aspects of Tsunami Simulations
The project, a collaboration with a seismologist and tsunami-researcher of ITB, has been submitted and is under review by KNAW; if granted the project will be executed for the major part at LMI, with senior scientists (from the project) working with young students (financed outside the project).

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 2007 this concerned research in mathematical optics.

- a. In the area of Mathematical Optics (SRO-EngMath), activities were executed in the LMI- project:
 - *Simulation of corrugated waveguide structures for optical add-drop multiplexer.*
 - *Modeling and simulation of photonic crystal structures using vector edge elements.*
 - *Investigation of pulse driven optical switching in 1D photonic crystal with defect.*

The projects was executed by LMI-scientists working with young students.

- b. In the area of *High Performance Computing*, an initiative to build a cluster computer started in December 2007. It is aimed that by February 2008 the cluster is fully functional.

II.4. Publications and Presentations

In Annex III we list the publications and presentations of work that was (partly) executed at LMI

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 2007, BSc graduates / MSc-students (Wenny Kristina, Laurentius Oscar Osaputra, Didit Adytia, Aimi Abass, Dede Tarwidi) worked at LMI for a total period of 24 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 2007, two students from UTwente (Aniek van der Valk and Bregje Buiteveld) worked at LMI for a period of three months to start the development of a Capacity Data Base.

▶ International Scientist Visitorships

LMI stimulates international scientific atmosphere by receiving visits of international scientists.

In 2007, three international scientists (Dr. Eifu Taguchi, AWI Bremerhaven, Dr. Remus Hanea, Univ. of Delft and Dr. Sjoerd Baas, Univ. Of Twente) visit LMI as lecturer of the RWSs.

▶ 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 2007 two PhD-students (Rifky Ismail and Made Parwata) and one PostDoc (Jamari) position were accommodated in this way.

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 has been appointed in 2007 as the official Info and 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. In 2007 we made a start with inviting individuals to become individual member, and university groups to become Institutional Member. A list will be published at the LMI website in the coming year.

VI. Facilities

VI.1. 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; collaboration with other groups and disciplines have been explored and will be developed further.

VI.2. 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.

In 2007 the Data Base was designed and information of various scientists was collected; in next years the data base will be further expanded.

VI.3. Supporting Staff

A temporary part-time position supports technical and computer software matters. Administrative staff has been appointed for secretarial and financial tasks (Mira Melania); by sharing the work with similar work for other activities within Yayasan AB, it is possible to employ them in part-time positions, while at the same time they can organise their total tasks in a most optimal way.

In 2007 a new staff member for internationalization (Imma Fitria Maharani) and a replacement for financial administration were arranged.

VI.4. Housing

Awaiting a more definite housing to be build, in 2007 LabMath-Indonesia had its office till March at Cigadung. In March LMI moved to the two times larger house at Anatomi 10. Since also that house became too small, early 2008 LMI will move again to a two times larger house in Anatomi 19. The new estate for LMI is under design, and expected to be ready in summer 2009.

In 2007 lecture rooms at ITB and at UNPAD were used for the Research Workshops.

VII. Personnel and Associate Scientists

Since its foundation, Dr. Andonowati acts as the Director of LabMath-Indonesia. Since March 2007 Dr. Ardhasena Sopaheluwakan is employed full-time and acts as Manager.

Starting January 2008 Prof. E. van Groesen will act as 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.

In 2007 the following appointments were related to LMI Residency-activities:
as senior scientists:

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

and as junior scientists:

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

VIII. Funding and subsidies

At 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. In 2007 we also started to perform on a small scale LMI-internal research; just as the Workshop activities, most of these costs have been covered by incidental subsidies from Yayasan AB. Possibilities are being explored to find activities that can provide structural financial contributions.

Also in 2007 subsidy from the Dutch Foundation 'Mathematical Physics, Christiaan Huygens' was received to support in particular the collaboration Indonesia-Netherlands in the area of Math Modelling and Simulation. This funding has been very important in the initial phase of LabMath-Indonesia.

Contributions to support the execution of Research Work Shops were received from the University of Twente, and from Universitas Padjajaran for the Summer RWS.

IX. Outlook

In 2007 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.

In 2007 we received strong moral support from KNAW (Netherlands Academy of Arts and Sciences), and from various universities that were visited and informed about the LMI-role as part of the UTwente-information activities.

Collaboration with UNPAD in executing the 2007 summer RWS will be followed by similar constructions with other universities in 2008.

The positioning as an independent, non-commercial institute that can sustain for many decades leads to the task to find structural funding for basic activities. With the construction of being part of Yayasan AB this can be overcome for the moment. Except for looking for support in the form of subsidy from external sources, application for research grants and commercialisation of research results will be part of the effort to reach sustainability.

Research Work Shop
COURSE WEEK
PROJECT WEEK

GEO-MATHEMATICS
INVERSE MODELLING
IN THE NATURAL SCIENCES
Final Announcement

15 - 26 January 2007
Bandung

Organised by



in collaboration with

- University of Delft, Netherlands
- Alfred Wegener Institute, Bremerhaven, Germany
- GeoPhysics Group, Institut Teknologi Bandung
- GITEWS consortium



Operations Research and Optimization Modelling

Methodology, algorithms and applications.

Final Announcement

06 - 16 August 2007

Bandung

EXTENDED DEADLINE for APPLICATION: July 23, 2007

*The BEST participants will be considered for a job
opportunity at NFS (New Frontier Solutions, an
International Management Consultancy Company)*

Organised by

 Laboratorium Matematika Indonesia (LabMath-Indonesia) www.labmath-indonesia.or.id	and	 Jurusan Matematika FMIPA Universitas Padjadjaran Indonesia
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In collaboration with



University of Twente, The Netherlands
Institut Pertanian Bogor, Indonesia
New Frontier Solutions Asia

LMI COLLOQUIUM

SEPTEMBER 2007



We invite you to attend the Colloquium of LabMath-Indonesia, Wednesday 19 September 2007
Place: LabMath-Indonesia office

- Ivan Lakhturov [University of Twente]: *Stokes waves phenomena on deep water* 10.00 - 10.25 ✖
10.25 - 10.50 ✖
Laurentius Oscar Osaputra [LabMath-Indonesia]: *Simulations of shallow water equations for the Indonesian bathymetry with Finite Element Method* 11.00 - 11.25 ✖
Mashuri [Institut Teknologi Bandung]: *Third order asymptotic solution of AB equation* 13.25 - 13.55 ✖
Lie She Liam [University of Twente]: *Pseudo spectral method for solving the IVP of the AB equation* 13.55 - 14.20 ✖
Didit Aditya [Institut Teknologi Bandung]: *Tsunami waveguiding phenomenon and simulations for synthetic bathymetries using pseudo spectral method* 14.30 - 14.55 ✖
Mohammad Bagus Adityawan [Institut Teknologi Bandung]: *2D modeling of overland flow due to tsunami wave propagation*

This invitation is also available online at: www.labmath-indonesia.or.id

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Annex II: List of LMI projects

Below is a list of projects in which LMI has been involved during the reporting period. Five projects are in the SRO GeoMathematics and four in the SRO Engineering Math for Technology.

1. SRO GeoMathematics

1.1

Title	Development of a Variational Boussinesq Model for tsunami simulations
Short description	Using a recently derived new Variational Boussinesq Model, this project designed and used various numerical implementations with the aid of which tsunami calculations have been performed. Effects of flow from deep ocean to the coastal area has been studied in detail with a pseudo-spectral implementation. A finite difference implementation was used to calculate flow over a bar, and compared to experimental data.
Funding Period	KNAW Mobility Programme 05MP-08 1 Jan 2006- 15 September 2007 (finished)
Participating groups	ITB, P2MS: Dr. Andonowati, ITB, Oceanography: Dr. Nining Sarih Ningsih UniBraw: Dr. Agus Suryanto, Dr. M. Nurhuda UTwente: Prof. E. van Groesen, Dr. O. Bokhove, Ir. G.Klopman U Sussex, UK: Dr. Djoko Wirosuetisno
Applicants / Supervisors	Prof. Van Groesen, Dr. Andonowati

1.2

Title	Extreme Water Wave Modeling: Toward Safety of Sea Transportation
Short description	Climate change is expected to lead to more extreme weather conditions. This may also have as effect that water heights in the Indonesian waters become larger; ships that are designed for calmer water will experience problems and sea transportation may be disturbed. Motivated by the necessity to ensure the safety of sea transportation, research on the extreme wave phenomena has become more and more needed. Part of this research is to do with the modeling of extreme wave propagation. Already for several years our research is for a major part related to the study of waves on the surface of a layer of fluid, such as water waves. This has led to publications dealing with various problems that have been tackled by models of varying accuracy. In two recent S3-theses we have reported about a striking discrepancy between the results of two often used surface wave models, namely the Boussinesq equations (B-eqns for short) and KdV-type of equations (KdV eqns for short). It turned out that wave heights in very nonlinear, extreme wavefields were correctly approximated by the B-eqns but not by the existing KdV eqns. This led us to derive a new KdV-type of equation, called the AB-equation. This AB-eqn has exact dispersion properties and is exact up to second order in the wave height. All investigations so far indicate

that this AB-eqn is indeed a much better model than the usual KdV type of equations. It is the aim of this research to further investigate the validity of this AB-eqn by trying to resolve the mentioned discrepancy by showing that for extreme wave fields.

This project will support efficient but accurate simulations of extreme waves by validating a recently derived AB-equation; this equation describes more accurately high waves than other known equations of KdV type. It will be shown that the mentioned discrepancy can be resolved and that for extreme wave fields the correct results using the B-eqn can also be correctly obtained by using the simpler AB-eqn. In that process we will study some aspects of large, extreme, water waves (including so-called freak, or rogue waves) from a theoretical and numerical point of view. The knowledge of extreme waves can support the generation of such waves in hydrodynamic laboratories to test ships in extreme weather conditions, and support bad-weather warnings for ships.

Funding Period	RISTEK (Insentif Riset Dasar) 1 April 2008 - December 2010
Participating groups	ITB, P2MS: Dr. Andonowati, ITB, Oceanography: Dr. N.S. Ningsih UTwente: Prof. E. van Groesen, Dr. O. Bokhove
Applicants / Supervisors	Dr. Andonowati

1.3

Title	Tsunami WaveGuiding in Indonesian coastal areas
Short description	<p>The activities in 2007 focussed to find tsunami-waveguiding areas along the Indonesian coast. Recently it has been shown for a synthetic geo- and bathymetry that shallow, transversal, areas in the bathymetry before the coast will act as waveguides that can lead to largely enhanced wave heights of incoming tsunami waves. The project indicated specific cases for the most tsunami-vulnerable places in the Indonesian coastal area where the bathymetry may show such waveguiding characteristics. Guided by the quantitative and qualitative characteristics of the geo- and bathymetry that leads to tsunami waveguiding, the actual search stretches from North-West Sumatra till the Sumba islands in the east; special attention was given to the coast before Meulaboh, Padang, Lampung, Pajajaran, West Jawa, Bali and Lombok.</p> <p>In 2008, the continuation provides the opportunity to extend the design of a FEM implementation of the Variational Boussinesq model, and to initiate theoretical research in the phenomenon of Tsunami Waveguiding. Continued and new research will deal with the following topics:</p> <ul style="list-style-type: none"> ➤ A careful analysis of the simulation results of possible near-coast waveguiding near Lampung, in particular an investigation of the 'wave form' and its transversal deformations. ➤ Further extension of the FEM-VBCode to include dispersion and bottom-generation software. It is intended to compare the FEM-VBCode with

	<ul style="list-style-type: none"> ➤ another new code developed at AWI-Bremerhaven, Germany. ➤ Start of theory of tsunami waveguiding above simple, synthetic bathymetries, using linear Shallow Water model. Similarities and differences with optical waveguiding should be understood.
Funding Period	University of Twente, AAMP 1 January - 31 December 2007, continued 1 January - 31 December 2008
Participating groups	LMI: Dr. Andonowati, A. Sopaheluwakan
Applicants / Supervisors	UTwente: Prof. E. van Groesen Dr. Andonowati

1.4

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. 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.</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. 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</p>

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 Period: NWO-AL (Netherlands), 1 PhD-student
 2008 - 2011
 Participating groups: UTwente: Prof. E. van Groesen, Dr. O. Bokhove
 LMI:
 Applicants / Supervisors: Prof. E. van Groesen

1.5

Title: **Integrating Indonesian Capacity for Coastal Zone Management** (application)

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 will contribute to a better Management of Coastal Zones by building an Integrated Capacity from elements that are now isolated at Indonesian institutions. The project will identify and improve the weakest subjects and maintain the integrated capacity. Scientists from Indonesian institutions and from Japan and Netherlands will collaborate.

Funding Period: APN
 1 April 2008 - December 2009 if granted
 Participating groups: ITB, P2MS: Dr. Andonowati,
 ITB, Oceanography: Dr. N.S. Ningshi
 ITB, Civil Engineering: Dr. Iwan Hardaja
 BMG, Jakarta: Dr. Dodo Gunawan
 Hiroshima University, Japan: Prof. Dr. Takao Yamashita
 Applicants / Supervisors: UTwente: Prof. E. van Groesen, Dr. J. Mulder
 Dr. Andonowati

1.6

Title: **Aspects of Tsunami Simulations** (application)

Short description: In a previous KNAW-Mobility Project, 05MP08 ‘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) will be 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. The topics were part of the previous 'ICESWA' Priority-Programme Application 05-LOI-10 to KNAW

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 05MP08 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.

Funding Period Participating groups	KNAW Mobility Programme 1 April 2008 - September 2009 LMI: Dr. Andonowati, Dr. A. Sopaheluwakan 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

2. SRO Engineering Math for Technology

2.1

Title	Simulation of corrugated waveguide structures for optical add-drop multiplexer
Short description	This project is designed for one of the award winners of the January 2007 RWS Aimi Abass. The topic of this project is about simulating corrugated planar waveguide structure as an optical add-drop multiplexer (OADM). OADM is used in a wavelength-division multiplexing systems for multiplexing and routing different channels of light into or out of a transmission line. This project is

	executed in LMI and partly supervised by Dr. A. Iskandar from Physics ITB. The result of the project is materialized in the form of the Bachelor thesis of Aimi Abass in Universitas Pelita Harapan, Jakarta.
Funding	LMI
Period	1 March 2007 - 1 August 2007 (finished)
Participating groups	LMI : Dr. A. Sopaheluwakan UPH, Physics: Aimi Abass ITB, Physics: Dr. A. Iskandar.

2.2

Title	Modeling and simulation of photonic crystal structures using vector edge elements.
Short description	The common practice of studying electromagnetic wave propagation in optical structure is to consider the propagation of the electromagnetic wave with a certain polarization. For optical structures with material and geometrical variation in one and two dimensions it is possible to write down a governing equation for only one of the components of the polarized wave. This (scalar) equation can then be solved with numerical methods, e.g. Finite Difference, Finite Elements, etc. The remaining component of the polarized wave can be determined through the relation between the wave components. However, this may create errors because of the differentiation process. Another approach which will be done in this project is to implement the vector edge basis function in a Finite Element procedure to represent the complete electromagnetic wave. This basis function satisfies the divergence free condition and so will the electromagnetic wave. This guarantees that the obtained FE solution is free of spurious solutions. This approach will be used to study various photonic crystal devices.
Funding	LMI
Period	1 July - continuing
Participating groups	LMI : A. Sopaheluwakan

2.3

Title	Investigation of pulse driven optical switching in 1D photonic crystal with defect.
Short description	It is well known that 1D photonic crystal structures with nonlinear refractive indices exhibit bistability phenomenon. This is particularly used in application as optical switches. Various studies have been done throughout the past decade studying this particular optical effect in 1D photonic crystal from various approaches. The common approach is by investigation in the frequency domain, incidence field to generate the bistability effect is a continuous (harmonic) field. It is known that by adding a defect layer to the 1D photonic

crystal, the threshold optical power to generate bistability effect can be decreased significantly. In this project we want to investigate the bistability effect of 1D photonic crystal with defect with pulses as the incidence fields. The investigation will deal with the following questions:

- Determining the relation between the pulse properties and material and geometrical properties of the photonic crystal, such that the energy content carried by the pulse is sufficient to 'pump' the photonic crystal to generate the bistable field.
- Describing the decay process of the bistable field that remains inside the crystal in terms of the properties of the photonic crystal.

Funding	LMI
Period	1 December 2007 - continuing
Participating groups	LMI : Dr. A. Sopaheluwakan, Dede Tarwidi

2.4

Title	Cluster computer for high performance computing.
Short description	<p>The continuous progress in scientific research increases the demand of more computational power. On the other hand, one of the results of scientific progress is the availability of more and more powerful computing facilities. This self-feeding cycle is pushing the search for knowledge towards very challenging investigations, and parallel computing nowadays plays an important role in this scenario.</p> <p>For the research activities that are conducted at LMI, the need for higher computational power is desirable. Through this project of building a small cluster computer, we try to build the knowledge and capacity of high performance computing in various aspects. It is also the aim that existing researches in the SROs will benefit directly from this project.</p>
Funding	LMI
Period	1 December 2007 - continuing
Participating groups	LMI : Dr. A. Sopaheluwakan, Aimi Abass, Adrianto Wijaya, Iqbal Yulizar, Didit Adytia, Dede Tarwidi

Annex III: Publications and Presentations

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

III.1 Publications (since June 2005)

2007

- E. van Groesen & Andonowati, Extremal periodic wave profiles, *Natural Hazards and Earth System Sciences*, **7**(2007) 33-40
- E. van Groesen, Andonowati, L. She Liam & I. Lakhturov, Accurate modelling of uni-directional surface waves, Special Issue of *Journal of Computational and Applied Mathematics* associated with Waves 2007, submitted December 2007
- N. Karjanto & E. van Groesen, Note on wavefront dislocation in surface wave fields, *PLA*, **371** (2007)173-179
- Andonowati, N. Karjanto, E. van Groesen, Extreme wave phenomena in down-stream running modulated waves, *Applied Mathematical Modelling*, **7**(2007) 1425-1443
- E. van Groesen & Andonowati, Variational derivation of KdV-type of models for surface water waves, *Physics Letters A* **366**(2007)195-201
- E. van Groesen, L. She Liam, I. Lakhturov & Andonowati, Deep water Periodic waves as Hamiltonian Relative Equilibria, *Proceedings of Waves 2007*, N. Biggs e.a. (eds), Reading UK, 23-27 July 2007, pp. 482-484; ISBN 0 704998 80 7.
- G. Klopman, M. Dingemans & E. Van Groesen, Propagation of wave groups over bathymetry using a variational Boussinesq model, *Proceedings Int. Workshop on Water Waves and Floating Bodies*, (eds: Šime Malenica and Ivo Senjanović), Plitvice, Croatia, April 2007, pp125-128.
- E. van Groesen, D. Adytia & Andonowati, Near-coast tsunami waveguiding: phenomenon and simulations, *Natural Hazards and Earth System Sciences*, November 2007, in press.
- E. van Groesen, D. Adytia, Andonowati & G. Klopman, Near-coast tsunami waveguiding: simulations for various wave models, Technical Report LMI-GeoMath-07/02, Oct. 2007, ISSN: 1979-1860.
www.labmath-indonesia.or.id/Reports/Reports.php
- A. Sopaheluwakan, Edge-element based finite element analysis of leaky modes of photonic crystal microcavities, *Proceedings of the International Conference on Optics and Laser Applications 2007*, Yogyakarta Indonesia, 5-7 September 2007, pp. 189-192; ISBN: 978-979-8575-05-1.
- A. Abass & A. Sopaheluwakan, FDFD Simulation of wave propagation in planar corrugated waveguide structures, Technical Report EngMath-07/01, Oct. 2007, ISSN: 1979-1860.
www.labmath-indonesia.or.id/Reports/Reports.php
- R. Ismail, Jamari, D.J. Schipper, Mild wear model: a literature review, Technical Report EngMath-07/02, Oct. 2007, ISSN: 1979-1860.
www.labmath-indonesia.or.id/Reports/Reports.php

2006

- E. van Groesen, Andonowati, Finite energy wave signals of extremal amplitude in the spatial NLS-dynamics, *Physics Letter A* (2006) **357**, 86-91
- E. van Groesen, Andonowati & N. Karjanto, Displaced Phase-Amplitude variables for Waves on Finite Background, *Phys.Lett. A*, **354** (2006) 312-319
- H. Margaretha, F.P.H. van Beckum, Andonowati, E. van Groesen, A. Jamaludin, A.M. Wijaya, Iterative methods for efficient generation of wave fields in hydrodynamic laboratory, *Journal of Indonesian Mathematical Society MIHMI* (2006) **12**, no. 1
- Andonowati, Wuryansari M. Kusumawinahyu & E. van Groesen, A numerical study of the breaking of modulated waves generated at a wave maker, *J. Applied Ocean Research*, **28** (2006) 9-17
- E. van Groesen, Variational Boussinesq Model, part 1: Basic equations in Cartesian coordinates; Technical Report LMI-GeoMath-06/02, 27 January 2006; revised 9 March 2006.

2005

- G.Klopman. M. Dingemans & E. van Groesen, A variational model for fully non-linear water waves of Boussinesq type, *Proceedings of 20th International Workshop on Water Waves and Floating Bodies*, Spitsbergen, Norway, 29 May - 1 June 2005.
- E. van Groesen & G. Klopman, Dispersive effects in tsunami generation, (2005), *Proceedings of The Indonesian Ocean Forum 2005*, 13-15 July, Bali Indonesia.

III.2 Presentations (since 2005)

2007

- A. Sopaheluwakan, *Edge-element based finite element calculation for photonic crystal microcavities*, (12-12-2007) Workshop on Computational Science 2007, Universitas Padjadjaran, Bandung, Indonesia.
- (06-09-2007) International Conference on Optics and Laser Applications, Yogyakarta, Indonesia.
- Andonowati, A. Sopaheluwakan, & E. van Groesen, *Aspects of Scientific Computing and Computational Science on Tsunami Wave Guiding*, (04-12-2007) International Conference on Computational Science, ITB, Bandung, Indonesia
- A. Sopaheluwakan, Andonowati, E. van Groesen, *Towards sustainable management of coastal areas affected by Global Change*, (20-11-2007) Open Science Meeting IV, SPIN KNAW-RISTEK, Bali, Indonesia
- D. Adytia, L. Oscar, E. van Groesen, *Tsunami phenomena and simulations*, (20-11-2007) Open Science Meeting IV, SPIN KNAW-RISTEK, Bali, Indonesia
- E. van Groesen, *Introduction Inverse Modelling*, (31-08-07) Math Workshop 'Math Modelling in Industry', Universitas Sebelas Maret (UNS), Surakarta, Indonesia (20-08-07) FMIPA Seminar, UniBraw Malang, Indonesia
- A. Sopaheluwakan & E. van Groesen, *Variational characterization and efficient FEM calculation of leaky modes of photonic crystal microcavities*, (10-08-2007) International Symposium on Modern Optics and its Applications, ITB, Bandung, Indonesia.
- E. van Groesen, Andonowati, Lie She Liam & I. Lakhturov *Characterization of Extremal Waves in KdV-type models*, (19-04-2007) European Geophysical Union, General Assembly, Vienna, Austria.
- E. van Groesen & Andonowati *Near shore Tsunami Wave Guiding*, (19-04-2007) Poster European Geophysical Union, General Assembly, Vienna, Austria.
- A. Sopaheluwakan, *Modeling the quality of photonic crystal microcavities*, (10-03-2007) Department of Physics, ITB, Bandung, Indonesia.
- E. van Groesen *Inverse Modelling in the Natural Sciences*, (15-21 January 2007) Two week Research Work Shop, LabMath-Indonesia, Bandung, Indonesia

2006`

- E. van Groesen (30-11-06) *Tsunami modelling and simulation form excitation to run-up*, Mathematics & EarthSciences, Groningen, Netherlands
- E. van Groesen (08-08-06) *Mathematical Modelling of Natural Hazards*, Indonesia-Germany Workshop on Vulnerability and Risk Assessment, Geoteknologi, LIPI, Bandung
- E. van Groesen (17-28 July 2006) *Research Work Shop GeoMathematics: Math and numerical modelling of Geophysical Flows*, LabMath-Indonesia, Bandung Indonesia
- E. van Groesen (07-04-06) *Generation phase of tsunamis in subduction areas*, EGU General Assembly 2006, Vienna
- Andonowati, E. van Groesen & N. Karjanto (07-04-06): *Extreme Waves on Finite Background* EGU General Assembly 2006, 2-7 April 2006, Vienna, poster presentation.
- Andonowati & E. van Groesen (23-27 January 2006), *Workshop on Tsunami Modelling and development of a new Variational Boussinesq Code*, LabMath-Indonesia, Bandung Indonesia

2005

- E. van Groesen (31-01-05) *Experimental verification of variational principles for extreme waves*, Lecture Workshop EU-Project ITB, Indonesia
- E. van Groesen (03-02-05) *Interaction of theory and experiments in generating and understanding ExtremeWaves*, Lecture Seminar EU-Project ITB, Indonesia
- E. van Groesen (05-02-05) *Optimization with constraints*, Lecture on occasion 70th Birthday Tjia May On, ITB, Indonesia
- E. van Groesen (28-02-05) *Variational principles for extreme waves* Lorentz-centre Leiden, 'Global and Variational Methods for ODE's and PDE's'
- E. van Groesen, (04-05-05) *Generation and propagation of tsunamis* Workshop 'Waves in Geosciences', ITB



- E. van Groesen, (13-07-2005) Dispersive effects in tsunami generation, The Indonesian Ocean Forum and 13th PAMS/JECSS Workshop, Bali Indonesia
- E. van Groesen, (19-08-05) *Coupled mode theory modeling of circular integrated optical microresonators*, International Symposium Modern Optics and its Applications, ITB Bandung, Indonesia
- E. van Groesen, (25-08-05) *On generation of tsunamis*, contribution Mini-symposium 'GeoMath' International Conference on Applied Mathematics ICAM05, ITB Bandung, Indonesia
- E. van Groesen, (28-09-05) *Iterative scheme for efficient wave generation in hydrodynamic laboratories*, Open Science Meeting III, Yogyakarta Indonesia.
- E. van Groesen, (28-09-05) *Coastal impact of seismically generated water waves*, Open Science Meeting III, Yogyakarta Indonesia.
- E. van Groesen, (28-09-05) *Variational modelling and simulation of surface water waves*, Open Science Meeting III, Yogyakarta Indonesia.
- E. van Groesen, (13-12-05) *Description of a nonlinear extension of the Benjamin-Feir instability as a coupled oscillator model*, lecture Rogue Waves 2005 ICSM Edinburgh, Scotland