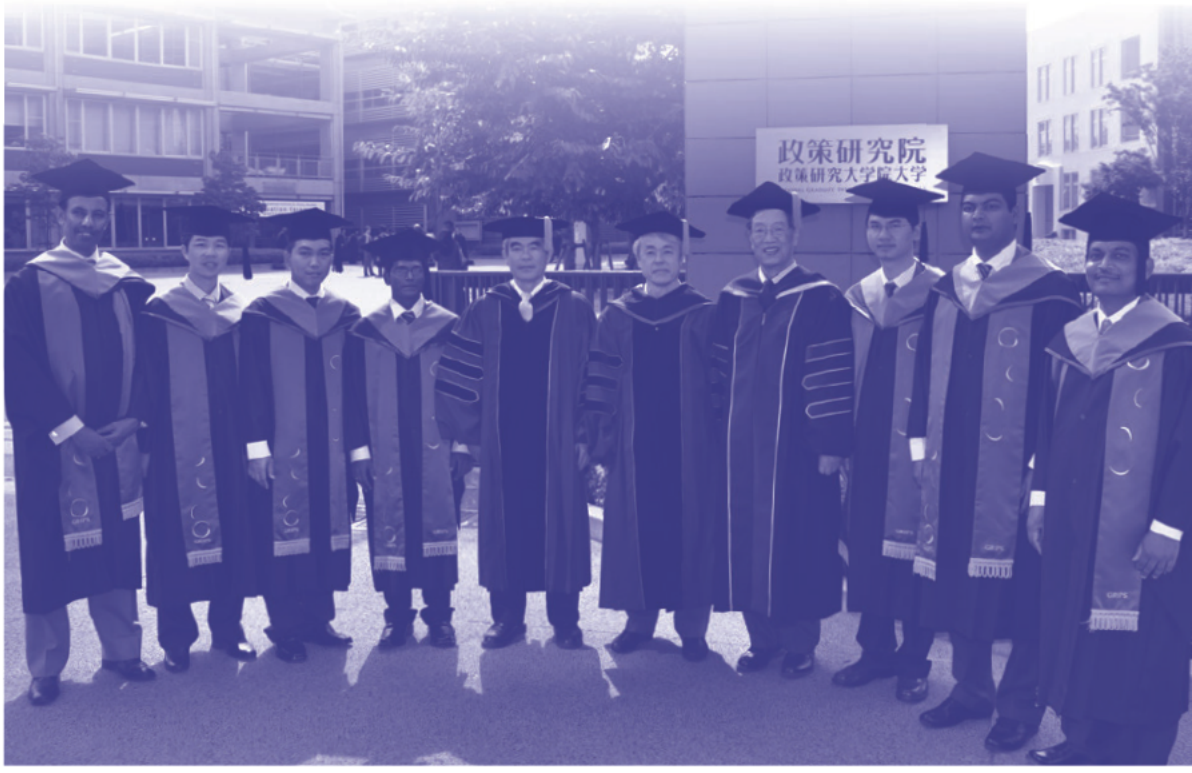


ＩＳＳＮ　０３８６－５８７８
土木研究所資料　第４１７０号

ICHARM Publication No.15J

2008-2009「防災政策プログラム 水災害リスクマネジメントコース」 研修実施報告書

平成22年1月



独立行政法人　土木研究所
水災害・リスクマネジメント国際センター（ICHARM）

United Nations
Educational, Scientific and
Cultural Organization

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土木研究所資料
第4170号　2010年1月

土 木 研 究 所 資 料

2008-2009
「防災政策プログラム
水災害リスクマネジメントコース」
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水災害・リスクマネジメント国際センター (ICHARM)

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「防災政策プログラム
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研修実施報告書

水災害研究グループ　　グループ長　田中　茂信
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主任研究員　栗林　大輔

水災害・リスクマネジメント国際センター（ICHARM）は、政策研究大学院大学（GRIPS）、（独）国際協力機構（JICA）と連携し、2008年9月29日から2009年9月19日にかけて、1年間の修士課程『防災政策プログラム　水災害リスクマネジメントコース』を実施した。研修生は、主として発展途上国の洪水関連災害防止・軽減に係る防災実務を担当する技術職員9人である。

本研修では、水災害被害軽減の総合的計画立案、実践活動に専門的な知識を持って参加できる実践的人材を養成することを目的としている。

研修の前半では主に講義・演習を実施し、後半では研修生の個人研究のために時間を充てた。また、日本の治水技術を学ぶために適宜現地見学を実施した。

本報告書は、研修の内容について報告するとともに研修に対する評価を行い、次年度の改善に資するものである。

キーワード：研修、防災、洪水災害

2008-2009「防災政策プログラム 水災害リスクマネジメントコース」
研修実施報告書

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Chapter 1:　防災政策プログラム「水災害リスクマネジメントコース」の背景

自然災害はどこで起こっても人間の悲劇と経済損失と引き起こし、国の発展を妨げる。特に、発展途上国においては都市化が進行し、貧しい者は自然災害に対してより脆弱な建物と地域に定住するため、発展途上国の貧困を削減する努力を大いにそぐことになる。

自然災害の中でも特に、洪水やかんばつのような水関連災害は、持続可能な人間社会の発展と貧困軽減を確実にするために克服されるべき大きな挑戦である。そのような破壊的な災害の数は総計的に増加しているだけでなく、急速な人口増加や、都市部における人口と貧困の集中化により、損害と影響の度合いを強めており、また高価値な資産の脆弱性を増加させている（図 1-1）。国連の世界人口推計（「世界都市化予測（2005）」）によれば、世界における都市居住者の数とその割合は今後も増え続け、このような人口増加のほとんどは発展途上国で起きると予測されている。例えば、2000 年から 2030 年の間に、アジアの都市人口は 13 億 6000 万人から 26 億 4000 万人に、アフリカの都市人口は 2 億 9400 万人から 7 億 4200 万人に急増すると見込まれている（図 1-2）。また、今後 10 年間の予測でも、ダッカ（バングラデシュ）、ムンバイ（インド）やジャカルタ（インドネシア）など海に面しているアジアの大都市で人口の急増が予想され、防災施設の整備などの対策が適切に行われない場合、洪水や暴風雨、津波など大規模水災害に対する脆弱性がますます高まるおそれがある（図 1-3）。

また、アジア地域は水関連災害による死者数のうち、世界の 80%以上を占めている（図 1-4）。今後、気候変化により降雨量やその降り方の分布パターンが変化することが予測されており、水関連災害の強度と頻度を悪化させる可能性がある。また、海面は地球温暖化のために世界中で上昇することが予測されており、そして、それは順番に海岸地域、河口のデルタ域と小さな島を危険にさらすことになる。

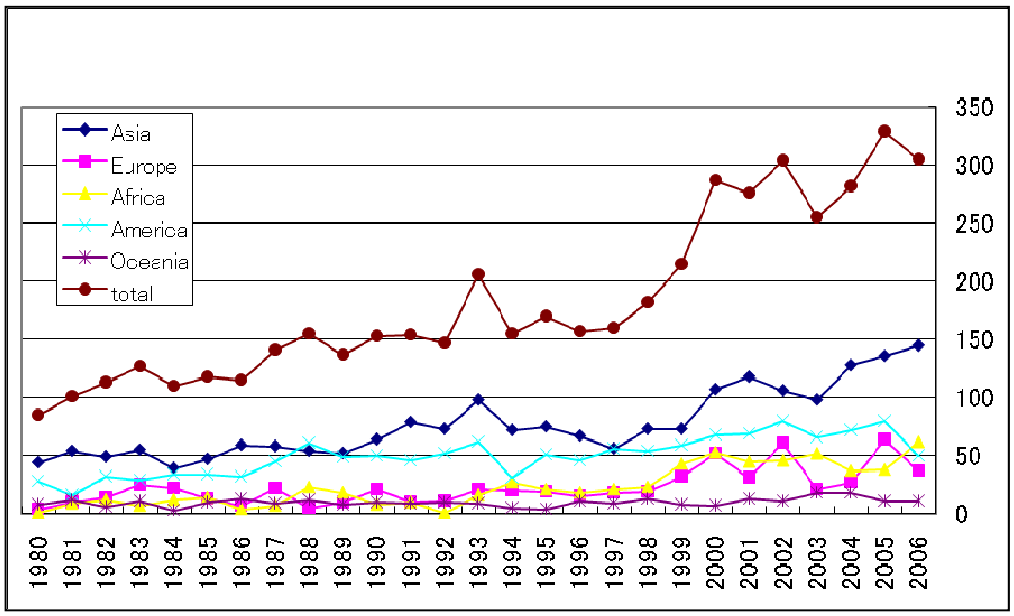


図 1-1　水関連災害数の経年変化（地域別）

（災害疫学センター(CRED)のデータをもとに ICHARM 作成）

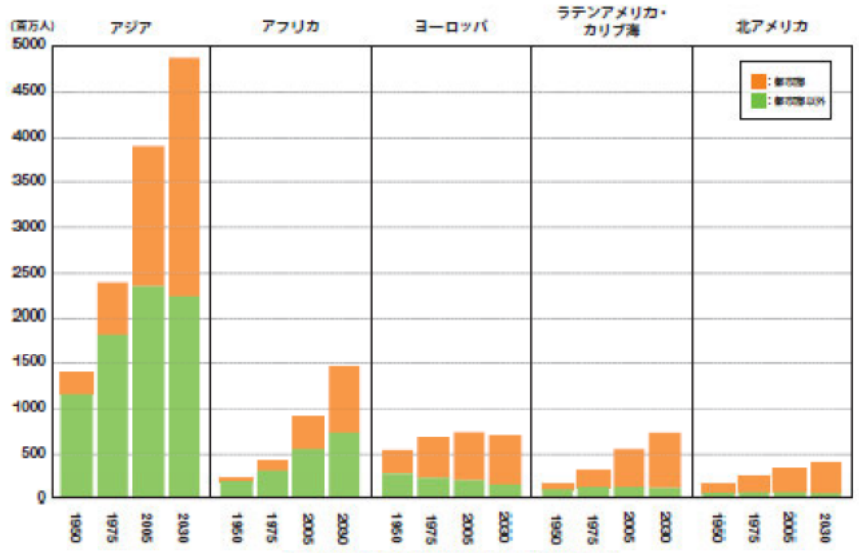


図 1-2　都市部と都市部以外の人口予測（地域別）

（国連の世界人口推計（国連経済社会理事会 人口部「世界都市化予測（2005）」）のデータをもとに ICHARM 作成）

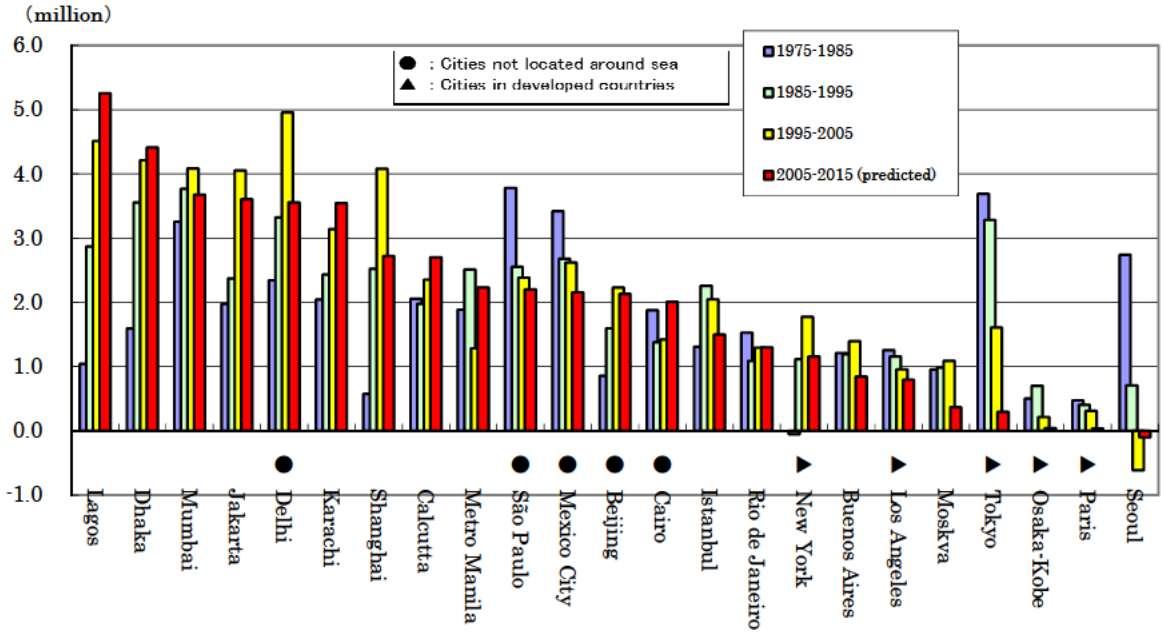


図 1-3　1975 年から 2015 年までの世界大都市における人口増加

（国連の世界人口推計（国連経済社会理事会 人口部「世界都市化予測（2005）」）のデータをもとに ICHARM 作成）

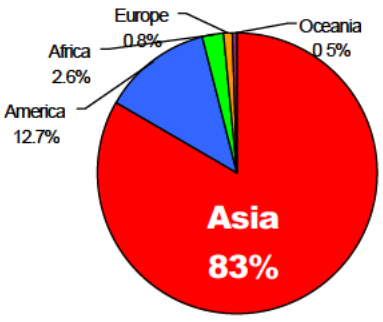


図 1-4

水関連災害による死者数の地域別分布(1980-2006)

（災害疫学センター(CRED)のデータをもとに ICHARM 作成）

このような自然災害の影響を減らすためには、災害の事前・事中・事後のバランスのとれた危機管理が多くの専門分野にわたってされなければならない。このため、専門教育とトレーニングを通して、適切な災害管理方針と地元の状況を考慮した技術を適切に開発し、コミュニティの防災意識を向上させるために地元の住民と様々な情報交換ができるように、災害管理の専門家を養育する必要がある。

これらの背景のもと、発展途上国において自然災害に対処できる専門家の能力を向上させるため、ICHARM は、政策研究大学院大学（GRIPS）と（独）国際協力機構（JICA）と協力し、2007 年から修士課程「防災政策プログラム　水災害リスクマネジメントコース」（以下、本修士コースと表記する）を立ち上げた。

国際連合は、ユネスコの主導のもとで 2005 年から 2014 年までを「教育と持続可能な開発のための 10 年」と定めている。本修士コースはまさにその理念に合致するものであり、かつ、ユネスコの後援のもとに設立された ICHARM がこのコースを運営することは、非常に光栄であると考えている。

Chapter 2:　コースの目的・特徴

2.1　コースの目的

Chapter1 で述べたような状況に対処するためには、災害が頻発している発展途上国における水関連災害専門家の育成が喫緊の課題である。そのような専門家には、災害に対する平素からの備えや災害時の復旧・復興に対して技術的・社会科学的な見地から、災害マネジメントに必要な幅広い知識を習得することが求められている。

本修士コースの目的は、国家レベルから住民のレベルまでのあらゆるレベルにおいて、統合的な河川流域マネジメントの枠組みでの洪水マネジメントの計画と実行に役立つことが出来、確固たる理論と技術に基礎を置く課題解決型実務者を養成することである。

そのため、本修士コースでは学生に以下のことが要求される。

- 水関連災害軽減に必要な、水文学、水理学、統合洪水マネジメント、ハザードマップ、ダム工学、砂防工学の基礎知識や記述を習得する。
- 水関連災害リスクマネジメント政策が基礎を置く理論を学び、日本の政策やシステムを理解する。
- 地元の状況に特化した適切な技術や政策の開発のための問題解決能力を向上させる。

2.2　コースの特徴

本修士コースの特徴としては、以下の 4 つを挙げることができる。

I. "Problem Solving-Oriented" course　（課題解決型研修）

大規模水災害に対応するためには、職員個人の能力向上も大事であるが、一人で出来ることにはおのずと限界があり、防災組織としての対応能力向上を図ることが必要不可欠である。

これまで実施してきた JICA 研修は、どちらかというと個人の能力向上を図る『人材育成型研修』に主眼が置かれていたが、近年、組織としての対応能力向上を目的とした『課題解決型研修』に軸足が移されている。これは、学生が自国における水災害に関する課題をまず特定・認識した上で、その課題を解決するために自ら主体的に学習すれば、個人としての効率的な学習効果が得られるとともに、所属する組織にとっても、課題解決のために有効な結果が得られると思われるからである。

このような考えから、本修士コースは「押しつけの研修」ではなく、「自ら考え、課題を解決する研修」を目指している。本修士コースの修士論文では、学生が自ら自国の課題解決に関わるテーマを研究することにしていることから、総合的な水災害被害軽減の総合的計画立案が可能な人材育成が図られ、帰国後の自国での課題解決促進にも役立つことが期待される。

II. "Students from the same organization"（同一組織から複数の学生）

本修士コースは、3 か年のうち 3 回の修士コースを実施するプロジェクトの一環であるが、前述のように防災組織としての対応能力向上を図るため、同一組織からなるべく複数の学生がこのプロジェクトで学ぶよう配慮している。そのため、対象国の関連組織に対し、優秀な学生を派遣して頂けるよう直接働きかけも行っている。

III. "Practical" rather than "Theoretical"　（理論よりも実務）

上記のように課題解決型の研修としているため、基礎理論よりも実務での応用が出来るような実践的な講義・演習ならびに現地見学を行っている。

IV. 1 year master's course　（1 年で修士号が取得できる）

本修士コースは、現在行政機関で働いている現職の職員を対象としているものであるため、業務に出来るだけ支障を来さないように、通常 2 年で取得する修士号を 1 年で取得できるよう運営されている。

2.3　コースの単元目標

本修士コースで学習することで、学生は以下のことが出来るようになる。

(1)　世界各地での統合洪水リスク管理における最近の方法について精通すること。

(2)　公共政策を含む地方及び国家レベルでの効果的なリスク軽減に必要とされるものを明らかに出来るようになること。また、地方及び国家レベルでのリスク管理体制、組織間の協調及び利害関係者を含む管理の体制について計画できるようになること。

(3)　非常時の対応及び災害リスク削減政策における変化を見つけ出し監視するための地方及び国家レベルでの指標を作り出し、これらの政策の状況及び効果を監視できるようになること。

(4)　明確な財政的、制度的及び法的枠組みのもとに新たに突き止められた統合リスク管理政策により作成された計画の履行に貢献出来るようになること。

(5)　リスク感知及び情報伝達問題や地球温暖化・気候変動などの新しい脅威に配慮しながら非常時の対応、復旧、緩和及び準備などの全ての管理構成要素を考慮に入れたリスク管理戦略を開発できるようになること。

また、本修士コース終了後、学生には以下のことが期待される。

(1)　日本における洪水対策の歴史的、行政的及び制度的背景を理解することで、自国での関係する問題とタスクを確認し、それら問題を克服し、関連する業務を履行するためのアクションプランを最終的に作成する。

(2)　自国における洪水災害軽減の必要性を理解する。
洪水災害軽減プロジェクトを計画し、可能なアクションプランを最終的に作成する。

(3)　洪水リスク評価やリスク軽減の知識や技術を理解し、習得する。
洪水ハザードマップを作成する。

(4)　ダムや砂防を含めた治水計画の策定のための知識や技術を理解し、習得する。
自国における対象流域で行うべきタスクを理解し、最終的に詳細なアクションプランを作成し、研修コース中にそのプランの妥当性が検証される。

2.4　コースの対象者

2008-2009 年度の候補国、対象機関、学生数、期間は以下の通りである。

Candidate Countries（対象国）:

8 countries (Bangladesh, China, Ethiopia, India, Indonesia, Nepal, Philippines, Thailand)

Eligible/Target Organization（対象機関）:

Technical officials, engineers or researchers in the field of river management or water-related Disasters（河川管理か水関連災害の分野における技師・技術者・研究者）

Total Number of Students（学生数）:

9students (2 Bangladesh, 2 China, 1 Ethiopia, 1 Nepal, 1 Indonesia, 2 Thailand)

（うちタイからの学生 1 名は 2008 年 11 月に体調不良のため帰国）

Duration（期間）:

29th September 2008– 19th September 2009 （2008 年 9 月 29 日-2009 年 9 月 19 日）

Chapter1 で述べた背景のもと、世界中から幅広く学生を募集するために、JICA 現地事務所を経由した JICA 学生としての学生募集と、それ以外の一般枠の学生募集を行った。

本修士コースは JICA 研修でもあるため、JICA との調整のもと、General Information (GI) を作成し、コース開始のほぼ半年前となる 2008 年 5 月に対象国に配布した。

また、JICA 研修対象国以外にも応募の門戸を広く開けるという考えのもと、GRIPS ホームページ上で 2 ヶ月弱の募集を行った。しかし残念ながら、今年度の応募はゼロであった。

選考の結果、9 名が合格となった。学生名簿を参考資料 2-1 に示す。なお、タイから来日した PUNBUNE Sarayuth 氏については、研修途中（2008 年 11 月）で体調不良のためやむなく帰国となった。

2.5 コースの実施体制

本修士コースは、（独）土木研究所が（独）国際協力機構 筑波国際センターから研修実施に関する委託を受け、所内においては以下の体制で実施した。

（独）土木研究所　水災害・リスクマネジメント国際センター（ICHARM）国際普及チーム

上席研究員	田中　茂信（2008.9～2009.7）、工藤　啓（2009.7～）
主任研究員	栗林　大輔
研究員	山下　英夫
非常勤職員	江橋　祥子
	鈴木　真理子（2008.9～2009.5）、内田　絵里（2009.5～）

Chapter 3:　コースの内容

3.1　コースの全体概念

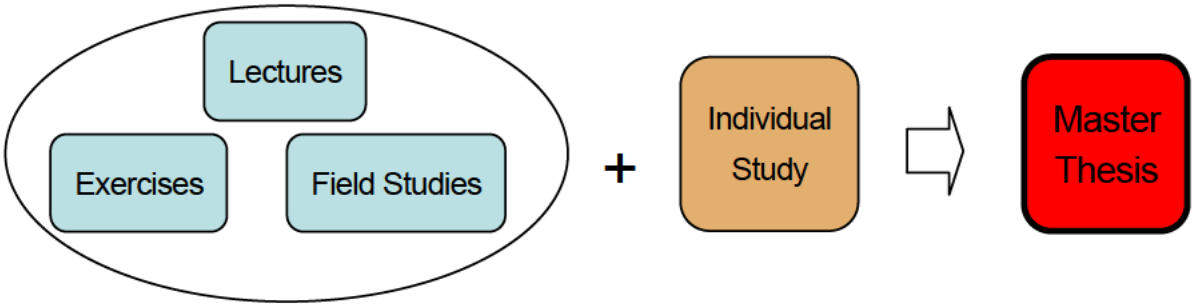


図 3-1　コース全体概念図

本修士コースは図 3-1 に挙げるように「講義」、「演習」、講義の理解を深めるための数回の「現地見学」および「個人研究」により構成されている。

学生には、講義や演習、及び現地見学で得られた知識をもとに、ICHARM の専門研究員と相談しながら個人研究を行い、最終的に修士論文として仕上げることが課されている。

3.2　コースのカリキュラム

2008 年 4 月 24 日に ICHARM 事務局と担当責任教官間で打ち合わせを行い、今年度のカリキュラム構成について協議を行った。その結果、以下の点について改善を行うこととなった。

- 科目別の講師の数を絞り、双方向型の講義を目指す。
- より時間数が必要な講義や内容が重複している講義・演習を以下のように再編する。
  - ・「Hydrology」を基礎と応用に分割
  - ・「Practice on Inundation Analysis」、「Computer Programming」を追加
  - ・IFRM(1)～(3)の 3 つの講義を、「Basic of IFRM」と「Flood Hydraulics and Sediment Transport」の 2 つに再編

この結果、今年度のカリキュラムを表 3-1 のように設定した。なお、昨年度からの変更点を参考資料 3-1 に示す。各講義・演習は本修士コースの単元目標には表 3-2 のように対応する。

本修士コースは、11 講座の「講義」、8 講座の「演習」、講義の理解を深めるための数回の「現地見学」および「個人研究」により構成されている。「講義」・「演習」についてはそれぞれ 15 コマで構成されている。参考資料 3-2 に本修士コースのカリキュラム一覧（講義・演習名と担当教官の一覧）を示す。本修士コースは課題解決型コースかつ実務を重視するコースであるため、水災害リスクマネジメントの基礎学習だけではなく、応用学習や演習を多く取り入れているのが特徴である。各講義の詳細なシラバスを参考資料 3-3 に示す。また、「講義」は全て必修科目（2 単位）、「演習」は全て選択科目（1 単位）、そして「個

人研修」は 10 単位である。修士号取得のためには、最低 30 単位を取得せねばならず、かつそのうち 16 単位は必修科目から取得しなければならない。その上で論文審査に合格すれば、「防災政策」の修士号が取得できる。参考資料 3-4 に GRIPS 及び ICHARM から学生に授与した学位記を示す。

また、講師陣には、ICHARM 研究員だけではなく、土研・国総研及び大学からも多くの講師を招き、学生が最新の情報を学習できるよう努めた。講師数は内部講師・外部講師含めて約 50 名程度である。講師一覧表を参考資料 3-5 に示す。

表 3-1　今年度のカリキュラム

			Credit
Lecture	Introduction to International Cooperation		2
	Basic Study for Water-related Disaster Management	Disaster Management Policy	2
		Disaster Risk Management	2
		Basic Hydrology	2
		Hydraulics	2
		Basic Concepts of Integrated Flood Risk management (IFRM)	2
	Application Study for Water-related Disaster Management	Advanced Hydrology	2
		Flood Hydraulics and Sediment Transport	2
		Local Disaster Management and Hazard Mapping	2
		Sustainable Reservoir Development & Management	2
		Control Measures for Landslide & Debris Flow	2
Exercise	Computer Programming		1
	Practice on Advanced Hydrology		1
	Practice on Hydraulics		1
	Practice on Inundation Analysis		1
	Practice on River Training		1
	Practice on Hazard Mapping & Evacuation Planning		1
	Practice on Sustainable Reservoir Development & Management		1
	Practice on Control Measures for Landslide & Debris Flow		1
Field Trip			
Individual Study			10

表 3-2　水関連災害に関する各種講義・演習

単元目標と研修内容	
1)　世界各地での統合洪水リスク管理における最近の方法について精通すること。	○ Basic Concepts of Integrated Flood Risk management (IFRM) ○ Introduction to International Cooperation
2)　公共政策を含む地方及び国家レベルでの効果的なリスク軽減に必要とされるものを明らかに出来るようになること。また、地方及び国家レベルでのリスク管理体制、組織間の協調及び利害関係者を含む管理の体制について計画できるようになること。	○ Disaster Management Policy ○ Disaster Risk Management ○ Local Disaster Management and Hazard Mapping ○ Practice on Hazard Mapping & Evacuation Planning
3)　非常時の対応及び災害リスク軽減政策における変化を見つけ出し監視するための地方及び国家レベルでの指標を作り出し、これらの政策の状況及び効果を監視できるようになること。	○ Computer Programming ○ Basic Hydrology ○ Hydraulics ○ Practice on Hydraulics ○ Advanced Hydrology ○ Flood Hydraulics and Sediment Transport ○ Practice on Advanced Hydrology ○ Practice on Inundation Analysis ○ Practice on River Training ○ Sustainable Reservoir Development & Management ○ Practice on Sustainable Reservoir Development & Management ○ Control Measures for Landslide & Debris Flow ○ Practice on Control Measures for Landslide & Debris Flow
4)　明確な財政的、制度的及び法的枠組みのもとに新たに突き止められた統合リスク管理政策により作成された計画の履行に貢献出来るようになること。	修士論文の作成
5)　リスク感知及び情報伝達問題や地球温暖化・気候変動などの新しい脅威に配慮しながら非常時の対応、復旧、緩和及び準備などの全ての管理構成要素を考慮に入れたリスク管理戦略を開発できるようになること。	○ (Basic Concepts of Integrated Flood Risk management (IFRM)) ○ (Local Disaster Management and Hazard Mapping)

3.3　コースのスケジュール

講義は「国連防災の日」を含む 2008 年 10 月第二週から開始された。全体スケジュールの概略を図 3-2 に示す。1 年間のスケジュールのうち、前半では主に講義・演習を行い、後半では各学生の個人研究の時間を確保した。さらに、1 年を通じて、日本の治水技術を学ぶために、現地見学を適宜実施した。

コース全体の講義・演習スケジュールを参考資料 3-6 に示す。

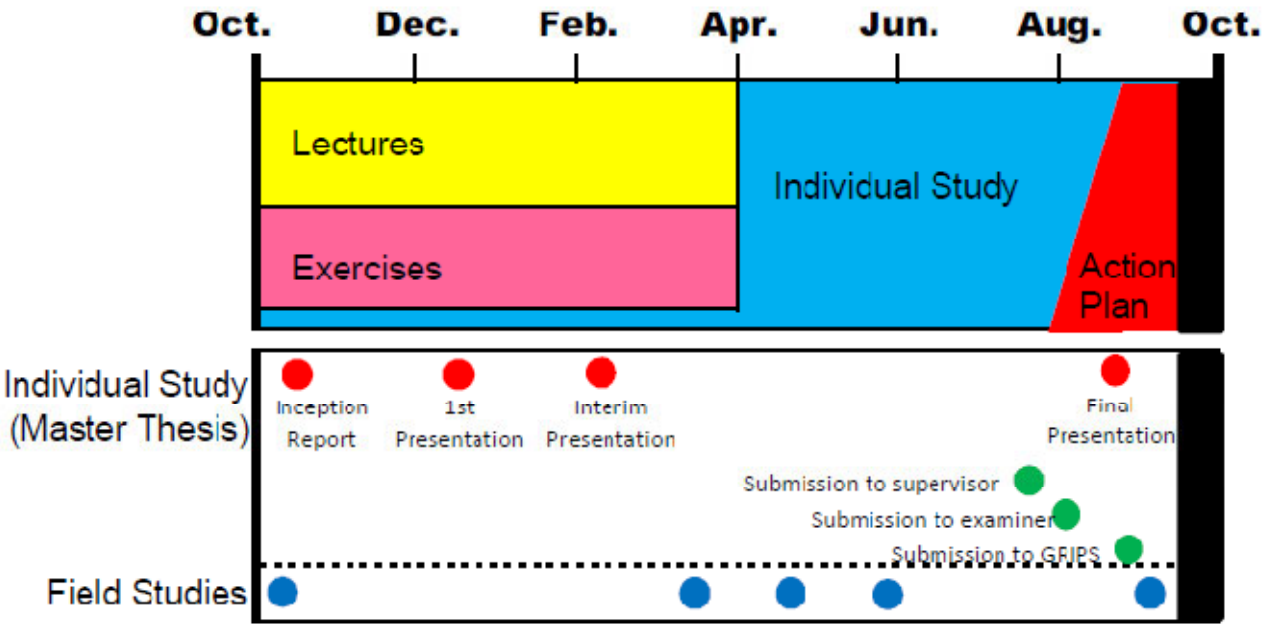


図 3-2　全体スケジュール概略図

また、時折 ICHARM が専門家を招いて実施する“ICHARM R&D Seminar”に学生を参加させて、最新の知識に触れる機会を与えたり、2009 年 5 月には利根川水防演習に参加させて、日本の水防について現地で学ぶ機会を提供したりした。さらに、月 1 度は Homeroom を開催し、学生からの意見を聞く機会を設けるようにした。

主たる年間スケジュールを以下に示す。

<September>

28th　Arrival in Japan

<October>

3rd　Opening Ceremony at GRIPS and Opening Party in ICHARM

7th　Field trip (1) to the Tokyo Metropolitan Area

11th -12th　Project Cycle Management (PCM) Practice

21st　Field trip (2) to the Tokyo Metropolitan Area

23rd　Homeroom

24th　Presentation on Inception Report

< November >

During November	Joint classes with the Flood Hazard Mapping training course
11th-14th	Field trip (3) to Chubu Region & Biwa Lake
13th	Town Watching exercise in Ise City
28th	Homeroom
< December >	
8th	Interview on Master Thesis
16th & 17th	Project Cycle Management (PCM)
24th	Interview on Master Thesis, Homeroom
< January >	
21st	Interview on Master Thesis
23rd	ICHARM R&D Seminar by Prof. Egashira on "Importance of introducing sediment transport process in river planning"
<February>	
9th	ICHARM R&D Seminar by Ms.Mandira on "Koshi Flood Disaster 2008"
<March>	
9th-12th	Field trip (4) to the Chugoku and Kinki Regions
27th	Homeroom
<April>	
2nd	ICHARM R&D Seminar by Prof. Kuroda on "Future activities of ICSU (International Council for Science)"
3rd	Cherry blossom viewing and tea ceremony at PWRI
7th	ICHARM R&D Seminar by Prof. Tamura on wind-related disaster reduction
14th	ICHARM Open Day
<May>	
16th	Field trip (5) The 58th Tone River Flood Fighting Drill in Sano City
27th	Interim Presentation of Master Thesis
<June>	
3rd-5th	Field trip (6) to Tohoku Region
<August>	
7th	Final Presentation on Master Thesis
18th 21st	Presentation at Japan Society of Hydrology and Water Resources & Field trip (7) to Hokuriku Region
28th	Submission of Master Thesis
<September>	
11th	11th International Summer Symposium
16th	Graduation Ceremony at GRIPS
18th	Closing Ceremony at JICA
19th	Departure from Japan

3.4 現地見学

本修士コースでは日本の治水対策についてより深く学ぶために、計 7 回の現地見学を実施した。参考資料 3-7 に見学箇所一覧とそれぞれの施設の概要と学習のポイントを示す。

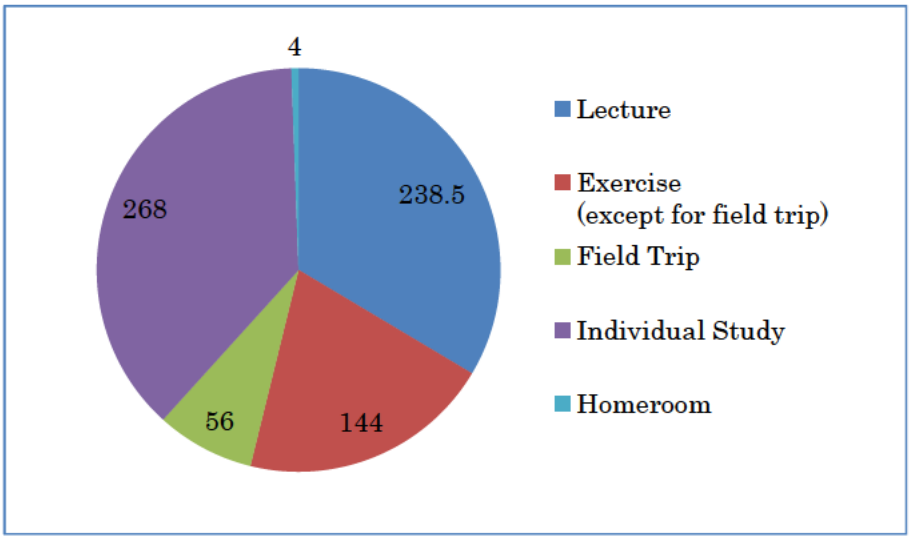
現地見学先は、講義で紹介された洪水対策施設や我が国における代表的な施設（渡良瀬遊水地や信濃川

大河津分水路など）を出来る限り自分の目で確かめられるよう配慮して選定した。また、斐伊川及び黒部川を上流から下流まで見学するなど、流域を意識した観点で行程を構成した。

また、見学後には学生にレポート提出を課し、ただの物見遊山にとどまらず各学生の理解を深めさせるよう配慮した。

3.5　コース全体における時間配分

本修士コースは前述の通り、「講義」、「演習」、「現地見学」および「個人研究」で構成されている。約1年間の期間のうち、それぞれにどの程度の時間が充てられたのかを図3-3に示す。



注）“Individual study”については個人差があるため、2月から3月は1日1.5時間、4月から8月にかけては、1日あたり2.5時間ICHARMスタッフからアドバイスを受けた時間として算出

図3-3　コース全体における時間配分（単位：時間）

全約710時間のうち、約4割の時間を修士論文の指導に充てており、修士論文作成には十分な時間であったと思われるが、次年度以降はさらに論文テーマ決定を前倒しするなどし、十分な時間を確保したいと考えている。

Chapter 4: 2008-2009 年度活動報告



政策研究大学院大学正門前で集合写真（2008 年 9 月 16 日）

ICHARM は、2008 年 9 月 30 日から 2009 年 9 月 19 日まで約 1 年間、（独）国際協力機構（JICA）および政策研究大学大学院大学（GRIPS）と連携し、修士課程『防災政策プログラム　水災害リスクマネジメントコース』を実施した。

当初 9 名の学生でスタートしたが、最終的に、学生 7 人（中国 2 名、バングラデシュ 2 名、ネパール 1 名、インドネシア 1 名、エチオピア 1 名）が無事に審査に合格して『修士（防災政策）』の学位を取得し、本国へ帰国した。

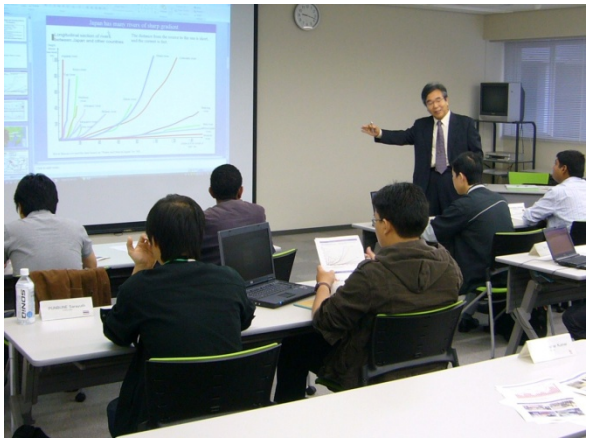


竹内邦良 ICHARM センター長による講義風景

本修士コースの特徴としては、1 年で修士号を取得できること、学生が自国で実際に抱えている問題の解決策を提案できる能力を向上させる『課題解決型』の研修であること、及び『理論より実務』を重視する研修であることなどが挙げられる。

コース前半では講義･演習を集中的に実施した。内容としては「Disaster Mitigation Policy」、「Disaster Risk Management」、「Basic Concepts of Integrated Flood Risk management (IFRM)」、「Hydrology」、「Hydraulics」などの基

礎的講義・演習だけではなく、「Flood Hydraulics and Sediment Transport」、「Local Disaster Management and Hazard Mapping」、「Sustainable Reservoir Development & Management」、「Control Measures for Landslide & Debris Flow」及び「Project Cycle Management」などの実務的な講義・演習も実施した。



福岡捷二教授（中央大学）による講義風景



江頭進治教授（ニュージェック）による講義風景



沖大幹教授（東京大学）による講義風景



Jayawardena 研究研修指導監による講義風景

2008 年 11 月は、ICHARM が別途実施した JICA 研修「洪水ハザードマップ作成」コースと合同で講義・演習を実施した。生徒数は両コース合わせてバングラデシュ・カンボジア・中国・エチオピア・インドネシア・ラオス・マレーシア・ネパール・フィリピン・タイ・ベトナムの 11 ヶ国から、合計 19 人にもなり、これほど多くの国籍の学生が一堂に会して授業や演習を行うことは、両コースの学生にとって大いに刺激になったと思われる。特に、三重県伊勢市においては、「タウンウォッチング」演習をグループ毎に実施し、各グループが実際に歩いたルートを地図上に作図しながら、洪水災害に対して事前にどのような対策や住民への意識啓発を行うべきか議論を行い、学生の理解を深めることが出来た。



「洪水ハザードマップ作成」研修との合同授業の様子



伊勢市大湊地区での「タウンウォッチング」演習



「タウンウォッチング」演習での
グループディスカッション

またコース全体を通して、日本の治水対策や水防工法、住民の防災意識についてより深く学ぶために、日本各地の現地視察を実施したり、住民の方からコミュニティ防災の取り組みについて直接話を聞いたりする機会を 7 回設けた。

まず、研修当初の 2008 年 10 月に渡良瀬遊水地、首都圏外郭放水路、江戸川スーパー堤防、神田川・環七地下調整池や鶴見川遊水地などを見学し、日本における洪水対策施設についての概要を学習した。なお、これらの見学は他の JICA 研修「総合的なダム及び河川」と合同で実施し、来日間もない本研修生間のアイスブレーキングの機会とした。



渡良瀬遊水地展望タワーにて

【関東地方整備局　利根川上流河川事務所】



首都圏外郭放水路調圧水槽内にて

【関東地方整備局　江戸川河川事務所】



善福寺川取水施設内にて神田川・環七地下調整池の説明

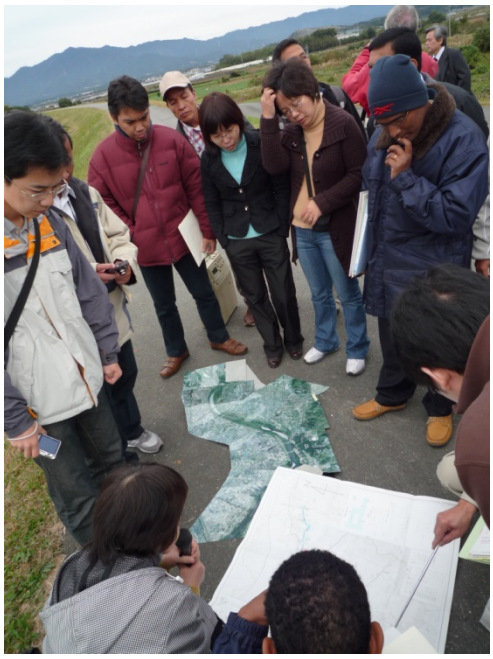
【東京都建設局 第三建設事務所】



鶴見川流域センター屋上から鶴見川遊水地見学

【(社) 雨水貯留浸透技術協会　忌部正博 理事による講義】

2008 年 11 月には、豊川霞堤、木曽三川分離事業、宮川改修事業および琵琶湖の水資源管理などを現地で学習した。また、伊勢市円座地区、大湊地区においてはコミュニティリーダーからコミュニティ防災についてのお話しもお伺いし、防災の基礎である「共助」の重要性に触れることが出来た。



愛知県 豊川霞堤上にて

【中部地方整備局　豊橋河川事務所】



国営木曽三川公園展望タワーにて三川分離事業の説明

【中部地方整備局　木曽川下流河川事務所】



水のめぐみ館（アクア琵琶）にて

琵琶湖の水資源事業概要説明



宮川改修事業の説明

【中部地方整備局　三重河川国道事務所】



団地での防災活動と 2004 年水害時の状況についての講話

（伊勢市円座地区にて上田武夫氏）



大湊地区での防災活動についての講話

（伊勢市大湊地区にて金森弘氏）

2009 年 3 月には、中国山地でのたたら鉄生産がいかに河川土砂輸送に関係したかを理解するための「和鋼博物館」（安来市）訪問、皆生海岸での養浜事業や「三点セット」での治水計画を進める斐伊川流域の下流から上流の尾原ダムまでの見学、広島市という大都市を河口部にもつ太田川の治水計画や砂防事業、および神戸市鷹取地区におけるコミュニティ防災活動のヒアリングと「人と防災未来センター」（神戸）の見学を行った。



「和鋼博物館」（安来市）訪問



境港公共マリーナにて皆生海岸事業概要説明

【中国地方整備局　日野川河川事務所】



大橋川コミュニティセンターにて斐伊川改修事業説明

【中国地方整備局　出雲河川事務所】



斐伊川下流部での事業概要説明

【中国地方整備局　出雲河川事務所】



斐伊川放水路建設現場見学

【中国地方整備局　斐伊川・神戸川総合開発工事事務所】



尾原ダム建設現場見学

【中国地方整備局　斐伊川・神戸川総合開発工事事務所】



太田川河川事務所での概要説明

【中国地方整備局　太田川河川事務所】



太田川河川事務所での概要説明

【中国地方整備局　太田川河川事務所】



太田川祇園水門の概要説明

【中国地方整備局　太田川河川事務所　大芝出張所】



人と防災未来センター（神戸）見学



金治宏氏による「たかとりコミュニティセンター」での
コミュニティ防災活動の講義

2009 年 5 月には、栃木県佐野市で行われた「第 58 回利根川水系連合水防演習」に参加し、水防工法の展示を見学したり、土のうづくりに参加したりするなど我が国の水防活動について学習した。





2009 年 6 月には、東北地方の現地を訪問し、灌漑用水の分水施設である「徳水園」（岩手県奥州市）や胆沢ダム建設現場並びに一ノ関遊水地の見学、岩手県奥州市羽田地区での住民に対するヒアリングや宮城県気仙沼市での防災活動への取り組みに関する講義を行った。なお、羽田地区での住民の皆さんとの意見交換の様子は、現地の新聞（胆江日日新聞）に掲載された。（参考資料 4-1）



「徳水園」（奥州市）での説明



胆沢ダム建設現場見学

【東北地方整備局　胆沢ダム工事事務所】



奥州市羽田地区の方へのヒアリング

（羽田公民館にて）



唐桑ビジターセンター（気仙沼市）内での講義

【気仙沼市危機管理課】



過去の台風による洪水実績標
（「道の駅　かわさき」にて）



「あいポート」における北上川治水計画の説明
【東北地方整備局　岩手河川国道事務所】

2009 年 8 月には、2004 年の中越地震の震源地近くで甚大な被害を受けた後、大規模な砂防事業が行われた芋川河道閉塞の現地、及び信濃川分水路・黒部川土砂対策・黒部ダムなどの現地視察などを実施した。



河川改修の説明
【北陸地方整備局　湯沢砂防事務所】



信濃川分水事業の説明
【北陸地方整備局　信濃川河川事務所】

修士論文作成に関しては、各学生がそれぞれの国での水災害に関する課題解決に資するために研究したい内容を尊重しながら、ICHARM 研究員が個別に面談を行い研究内容のサポートを適宜行った。学生は、不慣れな日本での長期間の生活に苦労しながらも、ICHARM 研究員から有用なアドバイスを受け修士論文を作成した。そして、2009 年 8 月 7 日に行われた修士論文の発表会では 1 年間の成果を各自披露した。







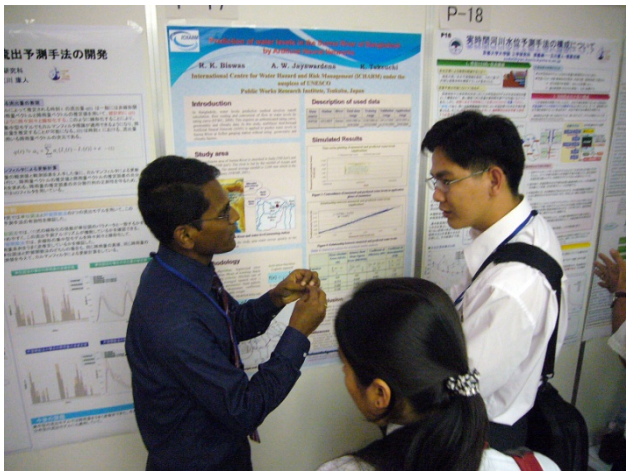


岡崎　健二教授（GRIPS）

論文作成を通じて、学生の知識が豊富になるばかりでなく、ICHARM にとっても学生との関係が緊密になるため、学生を通じたこのような国際的なネットワーク形成は、今後の ICHARM の活動にも大いに役立つものと思わる。

また、今年度のコースからは日本の学会への論文投稿を積極的に勧め、その結果 8 月の水文・水資源学会や 9 月の土木学会国際シンポジウムにおいて、それぞれ Biswas 氏（バングラデシュ）と Jin 氏（中国）2 名が発表することが出来た。さらに、Jin 氏は土木学会国際シンポジウムにおいて、当該セッションでの「最優秀賞」を受賞し、このことはもちろん本人の努力によるところが大であるが、本修士コース設立後、約 2 年をかけて他の大学に劣らない教育体制の充実に努めてきた結果であるとも受け止めており、今後とも一層の体制の充実に努めていきたい。

このような学生の発表の場を彼らへ提供し、よりよい修士論文作成への動機付けを行うことは今後も積極的に行っていきたいと考えている。



Biswas 氏による水文・水資源学会でのポスター発表



Jin 氏による土木学会国際シンポジウムでの発表



JAPAN SOCIETY OF CIVIL ENGINEERS

presents this

CERTIFICATE OF EXCELLENCE

to

Ke Jin

An Overview to Water Resources Management in Taihu Lake Basin: Challenges and Suggestions

in recognition for the distinguished presentation of his/her research achievements in an advanced comprehensible way during the 11th International Summer Symposium of Japan Society of Civil Engineers held on September 11, 2009 in Tokyo. The committees wish that this research may further flourish. Given this 11th day of September, 2009

Hitoshi FURUTA
Chair, International Activities Committee
Japan Society of Civil Engineers

土木学会から Jin 氏への表彰状

2009 年 9 月 16 日には、GRIPS にて学位授与式が、18 日には JICA 筑波にて閉講式が行われた。本修士コースで最も優秀な成績を修めた者に贈られる”Outstanding Award”は、バングラデシュの Biswas 氏に授与された。



学位授与式(GRIPS)



”Outstanding Award”授与

このコースの目的としては、社会的要請に必要な最新の技術を持ち合わせている専門家を養成し、その結果、一国の計画における災害マネジメントの重要性を彼らが政策決定者に提示することができるようにすることを掲げている。しかし、これは一朝一夕に出来るものではなく、帰国後も継続してフォローアップを行う必要を感じている。



JICA 筑波での閉講式集合写真（2009 年 9 月 18 日）

Chapter 5: 修士論文について

本修士コースは前述の通り、「押しつけの研修」ではなく、「自ら考え、課題を解決する研修」を目指した"Problem Solving-Oriented" course （課題解決型研修）を特徴の一つとしている。これに基づき、本修士コースの修士論文では、学生が自ら自国の課題解決に関わるテーマを研究することにしており、その結果として、総合的な水災害被害軽減の総合的計画立案が可能な人材育成が図られ、帰国後の自国での課題解決促進にも役立つことが期待される。

そのため、まず学生には、自国の課題紹介として、"Inception Report"を発表させ、修士論文の対象予定とするターゲットエリアに関する情報やプロジェクト履行に関する必要な行動について発表を行った。

さらに、2008 年 12 月には ICHARM 指導教官と学生が、取り組みたいテーマについて話し合いを行い、講義・演習がほぼ終了した 3 月下旬から本格的に各自の研究テーマに取り組んだ。

修士論文に関する主たるスケジュールを以下に示す。

<October>	
24th	Presentation on Inception Report
< December >	
8th	Interview on Master Thesis
24th	Interview on Master Thesis
< January >	
21st	Interview on Master Thesis
<May>	
27th	Interim Presentation of Master Thesis
<August>	
7th	Final Presentation on Master Thesis
28th	Submission of Master Thesis

各学生は、ICHARM 内の研究員と議論をしながら、8 月中旬に主査・副査に修士論文を提出し、審査された結果、タイの Khorsuk Banluesak 氏を除く 8 名中 7 名が「防災政策」の修士号を授与された。

各学生の修士論文タイトルと主査・副査を表 5-1 に示す。また、各論文の梗概集を参考資料 5-1 に示す。

表 5-1　修士論文リスト

Name	Title	Examiner/Supervisor
Robin Kumar Biswas (Bangladesh)	Water Level Prediction by Artificial Neural Networks in the Surma-Kushiyara River System of Bangladesh	Prof. Jayawardena Amithirigala (ICHARM) Prof. Shigeru Morichi (GRIPS), Prof. Shigenobu Tanaka (ICHARM), Asso. Prof. Kazuh ko Fukami (ICHARM)
Banda Mohd. Sarfaraz (Bangladesh)	Migration characteristics of meandering channels based on river morphodynamics	Prof. Shinji Egashira(Newjec) Prof. Kenji Okazaki (GRIPS), Prof. Shigenobu Tanaka (ICHARM), Asso. Prof. Katsuhito Miyake (ICHARM)
Jin Ke (China)	A methodological study to improve flood management of the Taihu Lake Basin	Prof. Kuniyoshi Takeuchi (ICHARM) Prof. Ikuo Shimomura (GRIPS), Prof. Shigenobu Tanaka (ICHARM), Asso. Prof. Jun Magome (ICHARM)
Xiao Fei (China)	HYDRAULIC MODELLING OF NENJIANG RIVER FLOODPLAIN IN NORTHEAST CHINA	Prof. Jayawardena Amithirigala(ICHARM) Prof. Shigeru Morichi (GRIPS), Asso. Prof. Junichi Yoshitani (NILIM), Asso. Prof. Katsuhito Miyake (ICHARM)
Alemu Yonas Tadesse (Ethiopia)	ANALYSIS OF SOCIO-ECONOMIC IMPACTS OF FLOODING IN DIRE DAWA, ETHIOPIA	Prof. Jayawardena Amithirigala(ICHARM) Prof. Kenji Okazaki (GRIPS), Asso. Prof. Junichi Yoshitani (NILIM), Asso. Prof. Jun Magome (ICHARM)
Maruli Tua Gregorius Simatupang (Indonesia)	IDENTIFICATION OF ILLEGAL RESIDENCE POTENTIAL EFFECT IN FLOODPLAIN AND SOCIO-ECONOMY EFFORTS FOR SOLUTION	Prof. Kuniyoshi Takeuchi (ICHARM) Prof. Shigeru Morichi (GRIPS), Asso. Prof. Junichi Yoshitani (NILIM), Asso. Prof. Pham Thanh Hai (ICHARM)
Manohar Kumar Sah (Nepal)	INUNDATION ANALYSIS AND DEVELOPMENT OF RAINFALL RUNOFF MODEL FOR TINAU RIVER BASIN IN NEPAL	Prof. Jayawardena Amithirigala(ICHARM) Prof. Hideo Fukui (GRIPS), Asso. Prof. Kazuh ko Fukami (ICHARM), Asso. Prof. Katsuhito Miyake (ICHARM),

Chapter 6:　コース評価と今後の課題

6.1　学生によるコース評価

コース全体を通じ、上半期に月 1 回程度、学生と ICHARM スタッフが意見交換する場として“Homeroom”を開催し、コース中盤には ICHARM と GRIPS それぞれが講義・講師に対するアンケートを行った。さらにコース最終日には、コース全体の評価を行う評価会を実施した。

表 6-1　本修士コースに対する評価の一覧

開催日	主な議題
“Homeroom” （上半期において 月 1 回程度開催）	ICHARM での生活面、 講義・講師に関すること、 個人研究に関すること　など全般
2008 年 3 月 中間アンケート（1）	（ICHARM によるアンケート） 半年間の講義・講師についての評価
2008 年 4 月 中間アンケート（2）	（GRIPS によるアンケート） 半年間の講義・講師についての評価
2008 年 9 月 評価会	（JICA アンケート） １．　設定された到達目標とニーズの適合について ２．　カリキュラム評価 ３．　研修期間について ４．　講師の講義プレゼンテーションについて、 ５．　テキスト、研修機材、講義施設について ６．　研修運営管理について ７．　期待充足度 ８．　到達目標達成度

以下、6.1.1 で中間アンケートから見た講義の評価、6.1.2 で中間アンケートから見た講師の評価、6.1.3 で評価会の結果から見たコース全体の評価を行う。

6.1.1　講義に対する評価

GRIPS によるアンケートでは、各講義・演習について表 6-2 に挙げる 14 個の観点からそれぞれ 5 段階で評価されている。各講義・演習に対する各項目の平均点のグラフを図 6-1、それを各講義について平均した結果を図 6-2、また各項目について平均した結果を図 6-3 に示す。

表 6-2　GRIPS によるアンケート項目一覧

講義について	1. The course was well-designed in order to provide students with good understanding of the content.（講義は学生に対して良い理解を与えるよう、よく設計されていた）
	2. The level (difficulty)of this course was appropriate. （講義のレベルは適切であった）
	3. The course helped me think logically. （講義は、私の論理的な思考を助けてくれた）
	4. I would like to recommend this course to other students. （この講義を他の学生にも勧めたい）
	5. The issues and the topics discussed during the class were appropriate and relevant to the goal of the course.（講義で触れられた内容は研修全体のゴールに対して適切で関連が深かった）
	6. The course was intellectually stimulating. （この講義は知的な刺激を与えてくれた）
	7. What I learned in the course will be useful for my future professional activities. （この講義で学んだことは私の将来の仕事に役立つであろう）
	8. The quantity, content, and level of assignments were adequate. （宿題の量や内容、レベルは十分であった）
講師について	9. The examination(s) and grading method were appropriate for the class. （テストや採点方法は適切であった）
	10. The instructor taught this course according to the syllabus. （講師はシラバスに沿って教えてくれた）
	11. The instructor presented ideas clearly and logically. （講師は明確にかつ論理的に考えを紹介してくれた）
	12. The instructor provided useful study materials. （講師は役立つ学習資料を与えてくれた）
	13. The instructor was well prepared for each class. （講師は授業の準備をよくしていた）
全体評価	14.As an overall evaluation, the course was useful and meaningful. （全体として、この講義は有用で役立つものだった）

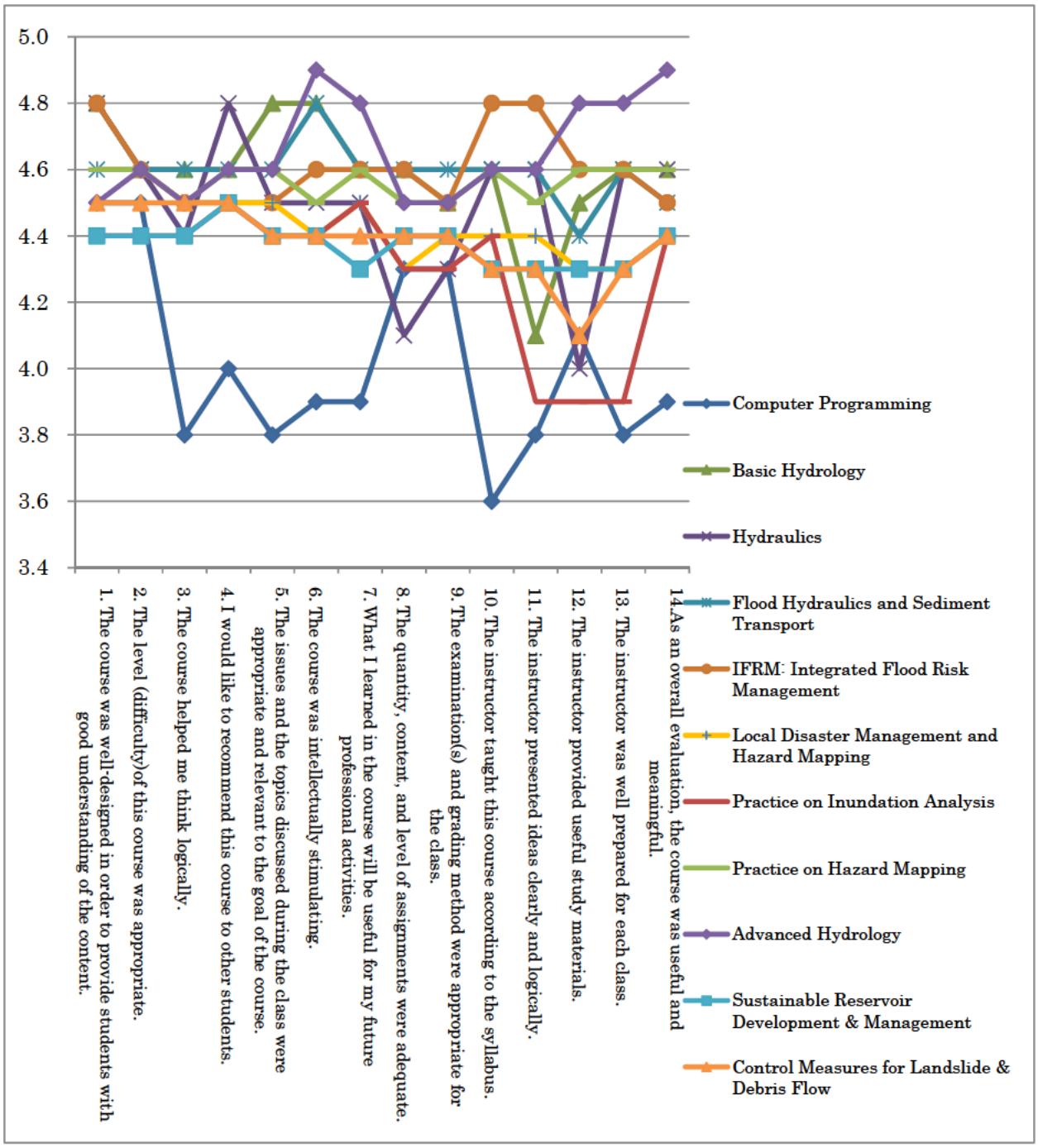


図 6-1　各講義に対する各項目での評価結果

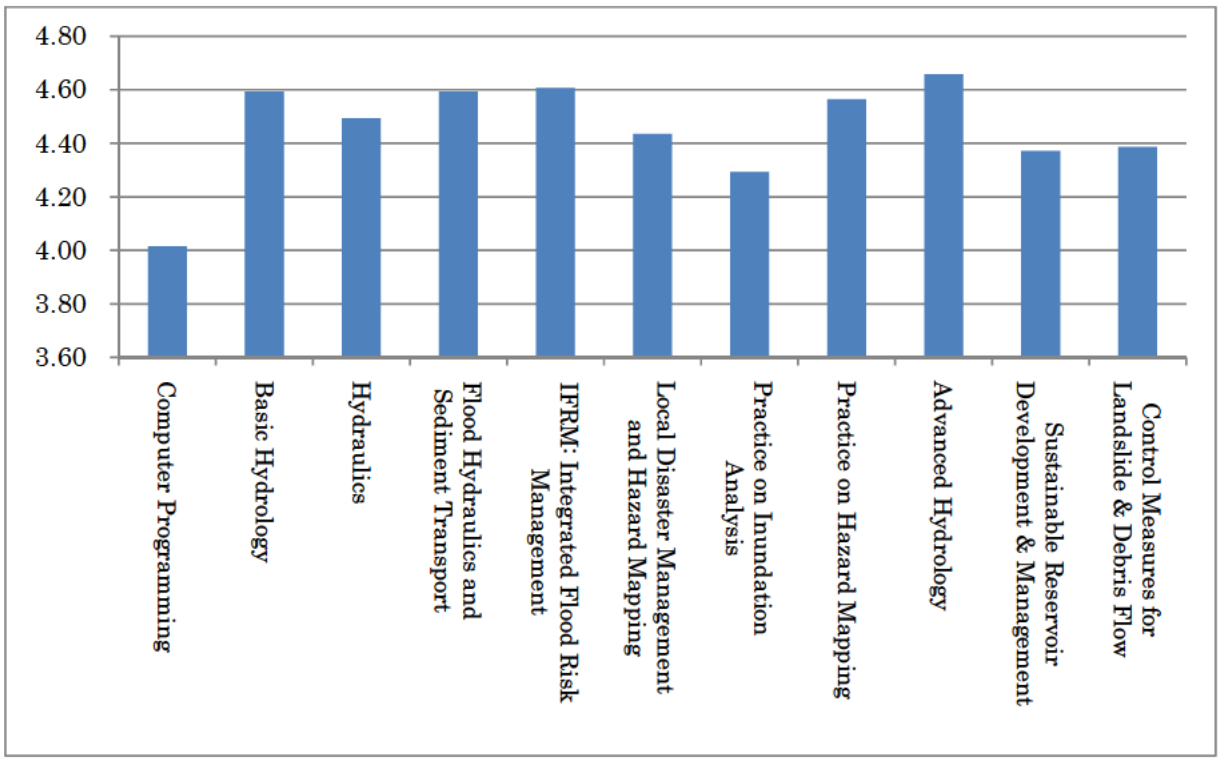


図 6-2　各講義について平均した結果

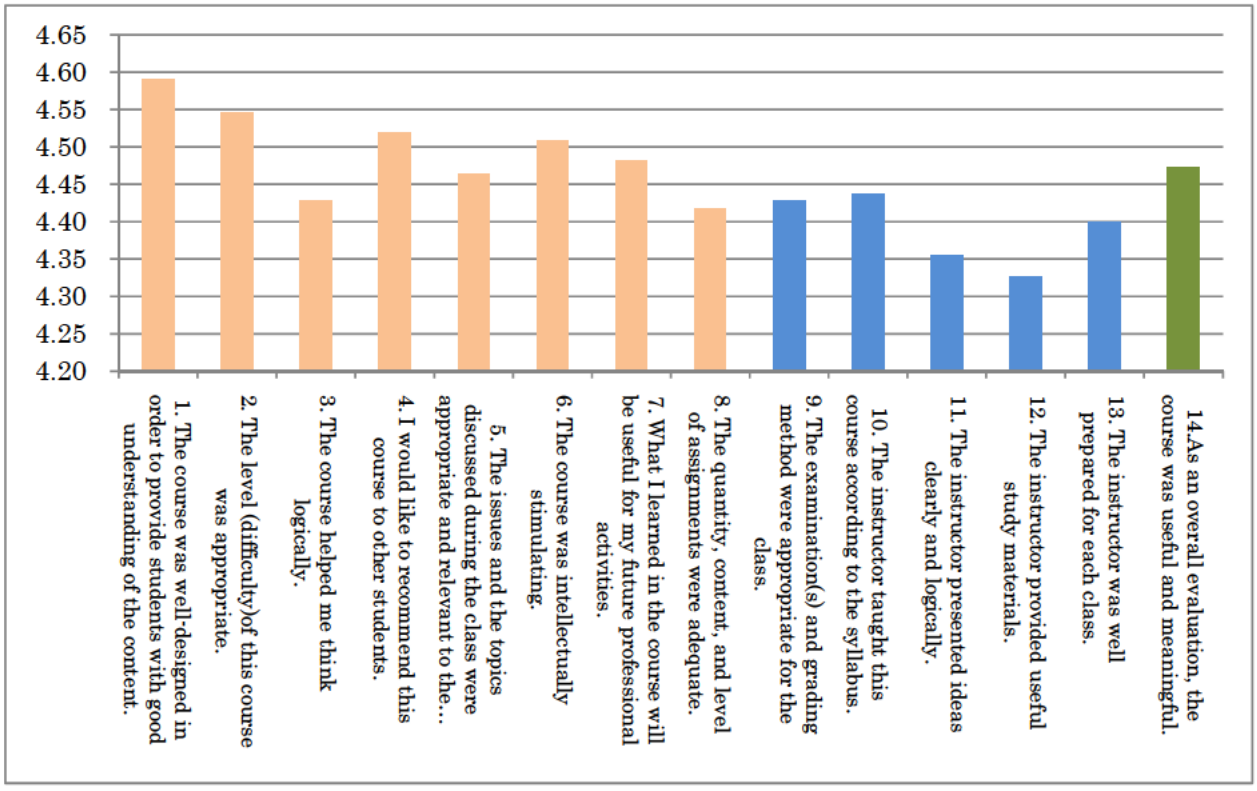


図 6-3　各項目について平均した結果

ICHARM によるアンケートでは、以下の設問を設定した。

Q-1　Please describe the good/bad points regarding to the subjects. (including practice) .
Q-2　Please fill in the name and the reason of **the best 5 useful lectures** for the water-related disaster mitigation in your country.
Q-3　If you think there are **any subjects of lectures to be added or deleted** to the course, please describe.
Q-4　Please fill in the name and the reason of **the best 3 lecturers** ***(Except for ICHARM Staff).***
Q-5　If you have any requests and comments for the course, please give us your opinions freely.

各講義に対しては、GRIPS のアンケートでは 5 段階による評価のみ、ICHARM の評価は自由回答のみであったので、双方の結果を俯瞰しながら、アンケート結果を分析する。なお、自由回答結果一覧を参考資料 6-1 に示す。

自由回答では、各講義とも好意的な回答が多いものの、中には次年度からの改善を要する指摘も含まれている。

図 6-1、図 6-2 から分かるとおり、“Computer Programming”の評価が相対的に低い。ただ、自由回答では、「現実問題に対する演習があればより助けになる」「もっと演習が必要」「Fortran だけでなく Visual Basic や他の言語も扱って欲しい」「より実務的な応用が欲しい」など、内容に不満と言うことではなく、逆に演習の時間が足りなかったことが最大の要因だと思われる。他の講義内容とリンクさせながらより実務的な演習を行う必要がある。

次いで評価の低い”Practice on Inundation Analysis”については、役立つ講義との評価も多いものの、指摘事項としては「使用されているモデルの理論的な背景、支配方程式を詳細に説明・議論して欲しい」「もっと時間が欲しい」との回答が多いため、モデルの利用方法だけではなく、その内容も説明するべきであったと思われる。

“Sustainable Reservoir Development & Management”や” Control Measures for Landslide & Debris Flow”については、幅広い内容をさまざまな講師によっておこなったため、ややもすると同じ内容が繰り返されたり、講義間の内容の繋がりが必ずしもうまくなかったりしたこともあり、自由回答では「(概要)説明だけで詳細がない」「コンセプトが明確に理解できなかった」などの回答もあった。次年度では、特に“Sustainable Reservoir Development & Management”では、1 冊の教科書を講義で通読して学ぶようにする予定である。

“Hydraulics”では、「演習が少ない」との回答が多かった。昨年度は現在の 2 倍演習時間を設定していたが、多いとの回答もあって今年度では半減させていた。カリキュラムの構成上、これ以上演習時間を増やすことは難しいため、宿題を課すなど自由時間での課題を充実させることが必要である。

“Practice on Hazard Mapping”では、国によっては地形図作成に利用するデータの制約で演習に難があることが指摘されており、日本のデータを用いて演習をさせるなど、改善が必要である。

図 6-3 から、評価の低い項目として、「11. The instructor presented ideas clearly and logically.（講師は明確にかつ論理的に考えを紹介してくれた）」「12. The instructor provided useful study materials.（講師は役立つ学習資料を与えてくれた）」が挙げられる。両方に関係することとして、ややもすると、膨大な数のパワーポイントスライドの説明に終始してしまい、グラフや図についての詳細な説明がないまま終了してしまう講義が多いことが原因であることが推察される。

6.1.2　講師に対する評価

ICHARM アンケートにおいて、『良かった講師ベスト 3』と『役立った講義ベスト 5』を各学生からあげてもらった。その結果を表 6-3 及び表 6-4 に示す。なお、『良かった講師ベスト 3』には ICHARM スタッフを含めないよう明記したが、含めている回答者もいる。また、講義と講師を混同している者もいた。

表 6-3　『良かった講師ベスト 3』

（有効回答：8 名）

No.	Best1	Best2	Best3
1	Prof. Fukuoka (Chuo Unvi.)	Dr. Osti Rabindra (ICHARM)	Prof. Takeuchi (ICHARM)
2	Prof. Fukuoka (Chuo Unvi.)	Dr. Fujisawa (PWRI)	Prof. Ish kawa (Tokyo Institute of Technology)
3	Prof.Jayawardena (ICHARM)	Prof. Fukuoka (Chuo Unvi.)	Prof. Ish kawa (Tokyo Institute of Technology)
4	Prof.Jayawardena (ICHARM)	Prof. Takeuchi (ICHARM)	Prof. Ish kawa (Tokyo Institute of Technology)
5	Prof. Ishikawa (Tokyo Institute of Technology)	Prof. Watanabe (Kitami Institute of Technology)	Prof. Fukuoka (Chuo Univ.)
6	Prof.Jayawardena (ICHARM)	Prof. Ishikawa (Tokyo Institute of Technology)	Prof. Takeuchi (ICHARM)
7	Prof. Fukuoka (Chuo Univ.)	Prof. Ishikawa (Tokyo Institute of Technology)	Prof. Watanabe (Kitami Institute of Technology)
8	Prof. Ishikawa (Tokyo Institute of Technology)	Prof. Egashira (NEWJEC Inc.)	Prof. Fukuoka (Chuo Univ.)

表 6-4　『役立った講義ベスト 5』

（有効回答：8 名）

No.	Best1	Best2	Best3	Best4	Best5
1	Local Disaster Management and Hazard Mapping	Practice on inundation analysis	Local Disaster Management and Hazard Mapping	Flood Hydraulics and Sediment Transport	Sustainable Reservoir Development & Management
2	Basic concept of IFRM	Local Disaster Management and Hazard Mapping	Flood Hydraulics and Sediment Transport	Sustainable Reservoir Development & Management	Control measures for landslide and debris flow
3	Basic hydrology	Advanced hydrology	Hydraulics	Computer Programming	GIS
4	Prof. Amithirigala Widhanelage JAYAWARDENA	Prof. Kuniyoshi Takeuchi	Prof. Fukuoka, Chuo Univ	Prof. Oki, Tokyo Univ	Dr. Amano, PWRI
5	Basic concept of IFRM	Basic hydrology	Advanced hydrology	Flood hydraulics and sediment Transport	Practice on inundation analysis
6	Basic hydrology	Advanced hydrology	Hydraulics	Basic concept of IFRM	Practice on inundation analysis
7	Basic & advanced hydrology	Basic concept of IFRM	Practice on inundation analysis	Flood hydraulics& sediment transport	Hydraulics
8	Basic concept of IFRM	Basic hydrology	Advanced hydrology	Flood hydraulics and sediment Transport	Practice on inundation analysis

表 6-3 からうかがえるように、ICHARM 以外の講師では、石川忠晴教授（東京工業大学）や福岡捷二教授（中央大学）の評価が高かった。特に福岡教授は、講義の時期とアンケートの時期が半年近く離れているにもかかわらず高評価であり、このことは、福岡教授の講義は印象深く、さらに学生のニーズに最も合致したものであったからと思われる。また、同じく高評価である渡邊康玄教授（北見工業大学）や江頭進治（ニュージェック技師長・前立命館大学教授）はともに洪水水理学や土砂輸送についての講義を担当して頂いており、実務で働いている学生にとっては最も有益な講義であったと思われる。今後、より内容を充実させて実施していく必要がある。石川教授の講義は板書が中心であり、水理学という基本事項をじっくりと教わったことが高評価に繋がっていると思われる。

また、昨年度と同様、選出されたほぼ全ての講師が大学教授である（あった）ことが特徴である。本修士コースでは約 50 名の講師の方に講義をお願いしており、全ての講師の方から素晴らしい講義を頂いているが、やはりその中でも大学の先生の評価が高いと言うことは、普段から教壇に立っている経験から、学生の集中力を持続させる方法を心得ているのが一因であろうと感じた。

表 6-4 からは、表 6-3 で挙げられた講師による講義の評価が高いことが見て取れる。「Flood hydraulics and sediment Transport」（福岡教授）、「Hydraulics」（石川教授）、「Basic Hydrology」・「Advanced Hydrology」（Jayawardena ICHARM 研究・研修指導監）、「Basic concept of IFRM」（竹内邦良 ICHARM センター長）や「Local Disaster Management and Hazard Mapping」（田中茂信 ICHARM グループ長）の評価は高い。これらは、図 6-2 の結果とほぼ合致している。「Practice on inundation analysis」は、GRIPS によるアンケート結果では相対的に低いものの、表 6-4 では高評価である。演習としての重要性は理解するものの、解析ツールの理論的な説明などが必要だと感じた学生が多かったことがうかがえる。

6.1.3　コース全体に対する評価

コース終了時に、学生に対し JICA からアンケートを実施した。以下にその結果を一部引用しながら分析を行う。

1．　単元目標の達成について

各学生ともおおむね達成できたとの回答であった。また、各単元は案件目標を達成する上で重要であるとの回答が多かった。

2．　各単元のコンテンツについて

「最も有益な講義」で挙げられた講義の多くは、表 6-4 とほぼ同じであった。また、今後追加すべき講義として、「防災を進めるための実現の方法」や「防災のための地域の活動」などが挙げられている。これらは、伊勢市での住民へのヒアリングなど、既に本修士コース内でも実施しているが、市町村担当者による現場の苦労話など、より充実していく必要があると思われる。

3．　プログラムのデザインについて

研修期間について「妥当」が 3 名、「短い」が 5 名であった。毎年、研修期間が短いとの声が多い。特に本修士コースでは 1 年で修士号を取得させるコースであるため、前半半年で講義・演習を終了して後半半年で本格的に修士論文に取り組むスケジュールのため、論文作成に割ける期間が短いことが原因

と思われる。次年度からは、修士論文のテーマ設定を今年度以上に早く行うなど、対策が必要である。

４．　研修で得た知識・経験は役立つか、どう役立てるか

「業務に直接活用することが出来る」(2 名)、「直接的に活用することはできないが、業務に応用できる」(6 名) との回答であったが、研修の成果を帰国後に活用するのは難しいとの回答が過半数であった。その理由としては、「自分が意志決定の権限を有していないため」(5 人)、「活用に必要となる予算の確保が難しいため」(5 人) が多かった。

本修士コースは、組織としての対応能力向上を目的とした「課題解決型研修」としての特徴を有しているが、この実現のためには学生所属機関の深い理解と協力が不可欠であり、単なる研修生の人材育成にとどまらず、所属機関の長まで巻き込んだ取り組みが必要と感じている。

6.2　ICHARM によるコース評価

6.2.1　学生のコース到達度達成評価

資格要件に外れた学生はいなかったが、途中で体調不良のため 1 名が帰国したことは残念である。

また、どの研修にも言えることではあるが、学生のレベルがまちまちであるため、講義や演習の実施に若干の支障を来す部分があった。修士論文の作成では、各学生が抱える課題解決に資するためにテーマを設定させるようこころがけたが、残念ながら 1 名は修士号を取得できなかった。

表 6-5 では、単元目標毎に達成度の評価を行った。

この結果、以下の研修目標については、

To develop the trainee's capacity to practically manage the problems and issues concerning water-related disasters in local levels and to contribute for socio-economic and environmental improvements in regional and national levels in developing countries.

学生は本修士コースにおける、"Basic Concepts of Integrated Flood Risk management (IFRM)" や"Local Disaster Management and Hazard Mapping"などの講義・演習を通じて現地コミュニティにおける水関連災害への実務的対処能力向上や、国家レベルからコミュニティレベルの各段階において、社会経済的・環境を重視した改善への貢献に必要となる知識や技術を習得することが出来たと考えられる。

さらに、以下の研修目標については、

Students are expected to become an independent investigator in the areas of integrated flood disaster management, who is equipped with the most advance technical and legal know-how to enhance the basic understand of the challenges of flood risks and to translate this knowledge back to a practical water-related disaster reduction strategies including poverty reduction and the promotion of sustainable development at local, national and regional level.

表 6-5　学生の達成度評価一覧表

単元目標	指標	達成度
1)　世界各地での統合洪水リスク管理における最近の方法について精通すること。	講義中のディスカッション、テストの実施	学生全員、講義やディスカッションを通じて統合洪水リスク管理に対する一般的な知識はおおむね理解できた。
2)　公共政策を含む地方及び国家レベルでの効果的なリスク軽減に必要とされるものを明らかに出来るようになること。また、地方及び国家レベルでのリスク管理体制、組織間の協調及び利害関係者を含む管理の体制について計画できるようになること。	現地でのタウンウォッチング、テストの実施	三重県伊勢市でのタウンウォッチングや住民へのヒアリングにより、洪水ハザードマップによるリスク軽減の有用性を理解できた。また、講義を通じてリスク管理についての日本の行政体制・法制度を理解できた。
3)　非常時の対応及び災害リスク軽減政策における変化を見つけ出し監視するための地方及び国家レベルでの指標を作り出し、これらの政策の状況及び効果を監視できるようになること。	レポートの作成、テストの実施	洪水管理に必要な水文学や水理学などの基礎知識、洪水管理のための主要な構造物である堤防やダム、砂防事業などについて、講義・演習ならびに現地見学を行いその重要性について理解できた。これらにより、非常時の対応及び災害リスク削減政策における変化を見つけ出し監視するための指標を作り出すことが可能になる。
4)　明確な財政的、制度的及び法的枠組みのもとに新たに突き止められた統合リスク管理政策により作成された計画の履行に貢献出来るようになること。	修士論文の作成	各学生は、自らの機関が抱える洪水関連問題を認識し、その解決のためにどのような政策が可能かを検討し、修士論文としてとりまとめた。
5)　リスク感知及び情報伝達問題や地球温暖化・気候変動などの新しい脅威に配慮しながら非常時の対応、復旧、緩和及び準備などの全ての管理構成要素を考慮に入れたリスク管理戦略を開発できるようになること。	講義の受講態度や演習の成果、修士論文への取り組み姿勢などを加味した総合評価	半年間での、様々な講義・演習、現地見学によって、学生は様々な知識、技術を習得し、リスク管理戦略を開発できる能力を身につけた。

学生は、"Hydraulics"や "Flood Hydraulics and Sediment Transport"や" Sustainable Reservoir Development & Management"などの講義・演習や日本各地への現地見学を通じて、洪水対策に必要な最新の基礎的・応用的知識を習得し、統合洪水マネジメント分野における専門家へ成長することができた。

今後、各学生は、本修士コースで習得した内容を自国の水災害被害軽減対策立案および履行に出来る限り資するよう努力する必要があり、さらにそれらをフォローアップできる体制づくりが望まれる。

6.2.2 コース全体に対する評価と今後の課題

1）昨年度からの改善点とその効果

3.2 で述べたように、学生の要望等を踏まえ、コースカリキュラムを再編したり、講義の数を増加させたりするなどの改善を行った。

「Hydrology」の講義に関しては、昨年度は 15 コマだけであったが、「水文学は内容が多い上にスピードが早い」との学生の要望に応える形で、今年度から「Basic Hydrology」15 コマと「Advanced Hydrology」15 コマに分割し倍増させた。その結果、表 6-4 でも挙げたように、両方の講義とも「学生からの役立った講義」の上位に入ることが出来、昨年度は「自国において最も有用と思われる講義」としてはあまり評価が高くなかったことを考えると、大きな進歩と言える。

また、今年度から「Computer Programming」を追加した。6.1.1 でも述べたように、学生からの表面的な評価はまだ高くないものの、自由意見から判断すると内容の改善次第で学生からの評価も高くなることも予想され、次年度は他の講義の内容も踏まえ、より実務に応用できる内容を追加して実施したいと考えている。

さらに、前年度での評価が高い講義として、「River Channel Planning」や「Concept of IFRM」「Outline of IFRM」が挙げられるが、これらは「IFRM(1)～(3)」の中の講義として実施された。しかし、「IFRM(1)～(3)」としては、「内容の重複等があり若干非効率である」との学生からの意見があったため、「IFRM」と「Flood Hydraulics and Sediment Transport」に再編した。その結果、ほぼ全ての学生が「役立った講義ベスト 5」にいずれの講義とも評価するなど、さらなる改善が図られたと言える。

2）全体を通じての評価

本研修は 2 年目となるコースだが、昨年度のさまざまな反省を踏まえて実施し、総合評価では全員単元目標を達成し、研修を終了することが出来た。

しかしながら、1 年目と比較すると学生間での能力のばらつきが大きく、優秀な者とそうでない者の差が大きく現れた。Biswas 氏と Jin 氏の成績上位 2 名は、水文・水資源学会（8 月実施）および土木学会サマーシンポジウム（9 月実施）でともに研究発表を行い、特に Jin 氏は土木学会サマーシンポジウムの発表セッションにおいて最優秀賞を獲得するなど、研修の成果が大いに現れたと言える。他方、提出まで 1 ヶ月となった段階でもまだ修士論文内容の掘り下げが浅い者や、期限内に論文を作成できずに修士号を授与されなかった者もおり、次年度において早急な対策が必要である。

また、毎年コースオリエンテーションの一環で、講義に遅れないことやレポートの締め切りには間に合わせるなどの基本事項を学生には徹底しているが、今年度コースでは昨年度以上に、時間や締め切りにルーズなところが散見された。前年度のコースでは3人の日本人学生がおり、外国人学生は彼らのやり方を見たり、日本人学生から教えられたりしながら、時間通りに行動することの重要性などを体得していったと考えられる。幸いなことに、2009-2010年コースには日本人学生が1名おり、同じような効果を期待している。

3）他の研修コースとの連携

本修士コースの最中となる11月には、JICA研修「洪水ハザードマップ作成コース」を並行して実施しており、ほぼ全ての講義・演習・現地視察を合同で実施した。

「洪水ハザードマップ作成コース」と合同で実施することにより、総勢19名、学生の国の数はバングラデシュ・カンボジア・中国・マレーシア・インドネシア・ネパール・ラオス・マレーシア・フィリピン・タイ・スリランカ・ベトナムと、アジアの中でも洪水災害多い地域をほとんどカバーする計12カ国で研修を行うこととなった。

そのため、非常に国際色豊かな研修となって学生間での交流が深まるとともに、講義・演習において活発な議論が行われた。次年度の研修コースにおいても、他の研修との連携を出来る限り行う方針としたい。

4）今後の課題

今年度のコース実施で見えてきた課題は以下の通りである。

＜修士論文の円滑な作成について＞

現在JICAにおいては日本語講習を実施しているが、英文での修士論文作成のためには、そのための英語研修も集中的に実施する必要がある。また引き続き、論文作成時の英文の指導も実施する必要がある。さらに、論文作成に必要となる基本的なパソコンソフトのワードやエクセルについても使い方を指導する必要がある。

＜修士論文の作成手順について＞

昨年度の反省を踏まえ、各学生には昨年度より早い段階で修士論文のテーマを考えさせ、さらにICHARMの専門研究員を個別にチューターとして配置し、修士論文に対する十分な時間や指導体制を整えたつもりであったが、そもそも自国における水関連災害の問題分析が浅い者などもおり、必ずしもこちらの意図したとおりに作成手順は進まなかった。

また修士論文の作成過程において、必要なデータ提供などの面で各学生の所属機関との連携・連絡が不十分の者がおり、所属機関にも当事者意識をいかに持たせるかが課題である。

＜現地見学について＞

学生にとって現地見学は、異国の治水対策を目の当たりに出来る貴重な学習機会であり、単なる物見遊山に終わらせないためにも、事前の予習、事後のレポート作成を課した。英文作成の基本能力を向上させるためにも引き続き実施する必要がある。

＜アクションプランについて＞

アクションプランについては、修士論文提出後に本格的に着手したため、帰国日までにあまり時間がなく、作成に時間が割けなかった。次年度以降は、修士論文提出を早め、アクションレポート作成にじっくり取り組ませる必要がある。

また、アクションプランをより現実的なものとするため、アクションプラン作成時に出身組織との連絡を課したり、半年後や１年後のフォローアップも行ったりするべきであろう。

＜帰国後のフォローアップについて＞

本修士コースの目的としては、社会的要請に必要な最新の技術を持ち合わせている専門家を養成し、その結果、一国の計画における災害マネジメントの重要性を彼らが政策決定者に提示することができるようにすることを掲げている。これは、一朝一夕に出来るものではなく、帰国後も継続してフォローアップを行う必要がある。

Chapter 7: 終わりに

7.1 本研修で得られた成果

ICHARM では「研修活動」は、「研究活動」・「情報ネットワーク活動」と並ぶ三本柱の一つに位置づけている。

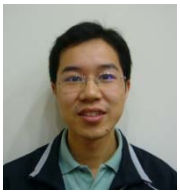
それを踏まえ、ICHARM はこれまでに JICA「洪水ハザードマップ作成研修」を 5 か年計画で実施し、2009 年度からは新たに 3 ヶ年計画で、防災機関としての組織対応能力向上を目指す JICA「洪水ハザードマップを活用した地域防災計画研修」を開始する予定である。

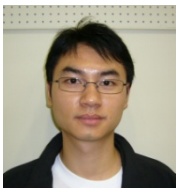
このたび、2 期目となる本修士コースを無事に実施したことで、ICHARM に研修企画・運営のノウハウがさらに蓄積されたことはもちろん、学生の修士論文作成を通じて対象国の水関連問題の解決にも資することになり、ICHARM が活動のキーワードとしている"Localism"への契機となっている。

また、本修士コースは、「情報ネットワーク活動」にも大きく寄与している。すなわち、学生の所属する組織とのつながりが毎年太くなり、様々な面で現地の状況が見えるようになってきた。学生を通じたこのような国際的なネットワーク形成活動は、今後の ICHARM の活動に大いに役立つものと思われ、研修終了後も密に連絡を取れる体制を継続することが求められる。

7.2 卒業生からのメッセージ

最後に 8 名のうち 6 名から寄せられた卒業生のメッセージを掲載する。

氏名	メッセージ
 Biswas Robin Kumar	Technology is always advancing for the betterment of mankind. Being a citizen of a developing country like Bangladesh, I was not well up to date regarding the modern technological development all around the world in the field of disaster countermeasures. I am extremely elated to pick the opportunity to study about the disaster in ICHARM. The designed course of this organization is practical oriented and will be helpful for me in coming days to serve my country effectively and efficiently. I am thankful to all the members of ICHARM for providing a pleasant environment of knowledge accumulation.
 Jin Ke	I am so proud to participate in this Master Program. China is a developing country which is suffering from frequent natural disasters. Huge amount of losses are caused by natural disasters each year. Japan is a developed country which has abundant experiences of disaster management and mitigation. Learning advanced technologies and experiences from Japan would surely contribute to the sustainable development of China. During my stay, ICHARM invited professors from different research institutes. They taught me lots of related theories, together with the causes, phenomena and prevention methods of different natural disasters. Theoretically discussing and practically application combined perfectly. This is my first chance to study abroad. I learned plenty of specialized theories and advanced disaster

	mitigation methods, and have formed a scientific way of thinking. Thanks to JICA, thanks to ICHARM, thanks to GRIPS, for giving me such a great learning opportunity. I would go on devoting myself to hard studying and striving for more progress. I believe in that the learning experiences here would momentously impact on my working ability after my returning to China.
 Xiao Fei	Time goes so quickly that this one-year master course of Water Related Risk Management will soon come to the end in September. I can still remember the time when I arrived in Japan, the most developed countries in Asia. Upon my arrival, I had a wonderful time and also I could build a better understanding of Japanese people, culture and the society. During this course, I achieved so much from the advanced lectures and reports of different topics, especially the lectures of Flood Risk management, Basic and Advanced Hydrology and Hydraulics, it would really help me a lot in my future works. One year is tough for me to learn so much knowledge and to complete the master thesis within six months. However, I could concentrate myself totally on the study since I had joined work, and it gave me a valuable experience and unforgettable memory. I am so grateful to GRIPS, ICHARM and JICA. And I really appreciate the comfortable studying and living environment that had been provided. I sincerely extend my great thanks to professors of GRIPS and ICHARM, with the knowledge I acquired from them I can do a better job.
 Alemu Yonas Tadesse, Ethiopia	ICHARM aims at contributing to the prevention and mitigation of water related disasters in the world. In the training sector ICHARM has did a lot to train students in a one year masters program. ICHARM has strong commitment and qualified staffs to equip students to be water related problem solvers and bring a difference in the water sector after completing their study. During the one year training program it is found that the curriculum for the program is well prepared, course contents are well selected and instructors are high standard. Moreover, the theoretical class lectures are supported by field excursion which gives good opportunity to students to realize how the theoretical knowledge could be implemented in the real environment in the field. This is one of the best practices which I observed in ICHARM during one year stay for training. The training program including the course delivered is quite important to produce qualified students and students who had the opportunity to study in ICHARM are confidential to involve and contribute their parts in the water related problems of their countries. Therefore, the master's program is very important in producing competent and responsible students in solving water related disasters. Moreover, staying in ICHARM not only helpful to study the subject matter of water related disasters rather it has the opportunity to learn how to collaborate and help each other and learn the importance of efficient utilization of time.

 Simatupang Maruli Tua Gregorius	"To be one of the participants in this “Flood-related Disaster Mitigation Master Program” is a great promising opportunity. I can learn a lot about flood and its mitigation and also special knowledge about mitigation policy. It is an interesting experience to study in Japan especially in ICHARM. Change information, experience and knowledge between all participants from other countries are one of the valuable things. Study in ICHARM is a big challenge because I can learn about flood from the experts. I hope all the knowledge which I acquire here can be implemented in my works specially to reduce the flood hazard in my country. Study in Japan is a thrilling and excited, because everything are organized well by ICHARM and JICA. The hospitality of Japan makes my stay become more pleasant. Last but not least, I would like to say sincerely thanks to all of lecturer and staff in ICHARM for great support during my study and to JICA by giving me a challenge to study in Japan. And also for all my friends, participants, for the great time that we spent together, helping and support each other, this is an unforgettable moment in my life."
 KHORSUK Banluesak	Living and studying in ICHARM are extremely far away from my normal life. We have to do everything in the short time which is tough for me. However, among the experts here, it is a very good opportunity to gain knowledge from them then apply that to our individual study and our work. This course is aiming to countermeasure for flood-related disaster. So far, we have learned a lot of things in various subjects, some are fundamental and some are applications. To be successful in disaster mitigation, we need both of them.

～謝辞～

本修士コースは 2 年目であり、1 年目の反省を踏まえて全体スケジュールやカリキュラムの見直しを行い、より充実を図ってきたが、まだまだ改善すべき点は多くあり、皆様のご意見を頂ければ幸いです。

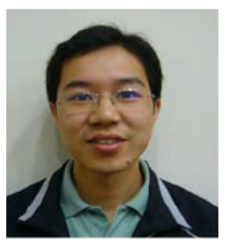
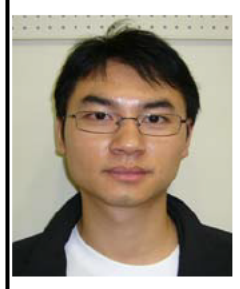
最後になりましたが、本修士コースを実施するにあたり、多忙な中講義や演習を行って頂いた各大学の先生方及び行政の方々、現地視察を快く引き受けて頂いた国土交通省事務所ならびに市町村の方々や住民の方々に厚くお礼申し上げます。

－参考資料－

参考資料 2-1　　学生名簿

Participant List of "Disaster Management Policy Program (Water-related Disaster Management) 2008-2009"

平成20年度「防災政策プログラム　水災害リスクマネジメントコース」 研修員名簿

		Country	Name	Age	Position
1		Bangladesh バングラデシュ	Biswas Robin Kumar ロビン　クマール　ビスワス 【Robin　・ロビン】	31	Assistant Engineer/ Bangladesh Water Development Board 技師補：バングラデシュ水開発局
2		Bangladesh バングラデシュ	BANDA Mohd. Sarfaraz モハマド　サルファラス　バンダ 【Banda ・バンダ】	27	Assistant Engineer/ Bangladesh Water Development Board 技師補：バングラデシュ水開発局
3		China 中華人民共和国	JIN Ke ジン　ク 【Jin ・ジン】	26	Section Staff of Office of FIlod Control and Drought Relief/Taihu Basin Authority of Water Resources 洪水監督・旱魃対策官(技師補)：タイフ盆地水資源公社
4		China 中華人民共和国	XIAO Fei ショウ　フェイ 【Xiao ・ショウ】	26	Engineer ofor Flood Management/Director of Bureau/Department of Hydrology and Water Commission, Liao Pine Ministry of Water Resources 洪水管理技師：水資源省ｿﾝｸﾞﾘｱｵ水資源委員会
5		Ethiopia エチオピア	ALEMU Yonas Tadesse アレム　ヨーナス　タデッサ 【Yonas　・ヨーナス】	36	Lecturer / Dire Dawa University 講師：ﾃﾞｨﾚﾀﾞﾜ大学
6		Indonesia インドネシア	Simatupang Maruli Tua Gregorius マルリ　ツァ　グレゴリウス　シマツパン　【Gregorius ・グレイ】	27	Engineer / Directorate River, Lake and Reservoir DG of Water Resources, Ministry of Public Works 担当官(技師)： 公共事業省自然災害対策・河川/湖/貯水池・水資源局
7		Nepal ネパール	SAH MANOHAR KUMAR マノハール　クマール　シャー 【Sah ・シャー】	40	Civil Engineer / Department of Water Induced Disaster Prevention 土木技官：水災害防害局
8		Thailand タイ	KHORSUK Banluesak コースク　バンルェサック 【Khorsuk ・コースク】	35	Meteorologist/Hydro-Meteorological Group, Thai Meteorological Department, Ministry of Information and Communication Technology 気象官：情報通信技術省タイ気象庁降雨気象ｸﾞﾙｰﾌﾟ
9		Thailand タイ	PUNBUNE Sarayuth パンブン　サラユー 【Sarayuth ・サラユー】	33	Irrigation Engineer/Regional Irrigation Office 11, Royal Irrigation Department, Ministry of Agriculture and Cooperatives 灌漑技師：農業・協同組合省王立灌漑局地域関灌漑室11

参考資料 3-1　　昨年度からのカリキュラムの変更点

防災政策プログラム　水災害リスクマネジメントコース
講義・演習　変更一覧表（案）

ICHARM

【講義】

前年度		今年度	担当講師
(1) 水文観測とモデリング	→	(1) 水文学基礎	ｼﾞｬﾔﾜﾙﾀﾞﾅ　指導監（ICHARM）
(2) 河川工学	→	(2) 水文学応用	ｼﾞｬﾔﾜﾙﾀﾞﾅ　指導監（ICHARM）
(3) 統合洪水マネジメント(1) 基本的概念と世界の潮流	→	(3) 河川水理学	石川　忠晴　教授（東京工業大学）
(4) 統合洪水マネジメント(2) 非構造物対策とコミュニティ防災	→	(4) 統合洪水リスクマネジメント	竹内　邦良　ｾﾝﾀｰ長（ICHARM）
(5) 統合洪水マネジメント(3) 構造物対策	→	(5) 河川計画及び河川工学	福岡　捷二　教授（中央大学）
(6) 洪水ハザードマップと避難計画	→	(6) 地域防災とハザードマップ	田中　茂信　上席研究員（ICHARM）
(7) ダム工学	→	(7) ダム工学	松本　徳久　顧問（(財)ダム技術センター）
(8) 地すべり対策と砂防	→	(8) 地すべり対策と砂防	大久保　駿　理事長（(社)治水砂防協会）
(9) 防災分野における国際協力	→	(9) 防災分野における国際協力	石渡　幹夫　国際協力専門員（JICA）
(10) 防災政策	→	(10) 防災政策	森地　茂　教授（GRIPS）
(11) 災害リスクマネジメント	→	(11) 災害リスクマネジメント	岡崎　健二　教授（GRIPS）

【演習】

前年度		今年度	担当講師
(1) 水文観測とモデリング　演習	→	(1) 水文学応用演習	ｼﾞｬﾔﾜﾙﾀﾞﾅ　指導監（ICHARM）
(2) 河川工学　演習	→	(2) 河川水理学演習	石川　忠晴　教授（東京工業大学）
(3) 統合洪水マネジメント　演習	→	(3) 河川計画及び河川工学演習	福岡　捷二　教授（中央大学）
(4) 洪水ハザードマップと避難計画 演習	→	(4) 氾濫解析演習	田中　茂信　上席研究員（ICHARM）
	→	(5) ハザードマップ作成演習	田中　茂信　上席研究員（ICHARM）
		(6) プログラミング演習	田中　茂信　上席研究員（ICHARM）
(5) ダム工学　演習	→	(7) ダム工学演習	松本　徳久　顧問（(財)ダム技術センター）
(6) 地すべり対策と砂防　演習	→	(8) 地すべり対策と砂防演習	大久保　駿　理事長（(社)治水砂防協会）

参考資料 3-2　　カリキュラム一覧

2008-2009 Disaster Management Policy Program (Water-related Risk Management Course) Recommended Courses

Lecture	Introduction to International Cooperation		Disaster Mitigation Policy		Disaster Risk Management		Basic Hydrology		Hydraulics		Basic Concepts of Integrated Flood Risk management (IFRM)	
Number	DMP181E		DMP200E		DMP201E		DMP280E		DMP281E		DMP282E	
Lecturer	Mr. Mikio Ishiwatari		Prof. Shigeru Morichi		Prof. Kenji Okazaki		Prof. Amithirigala Widhanelage JAYAWARDENA		Prof. Tadaharu Ishikawa		Prof. Kuniyoshi Takeuchi	
Period	Fall through Winter		Winter		Winter		Fall through Winter		Fall through Winter		Fall through Winter	
	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer
1	International activities by JICA	Mr. Ishiwatari, JICA	Introduction: Coverage of this class Disaster mitigation policy	Prof. Morichi, GRIPS	Introduction: Disasters in the world	Prof. Okazaki, GRIPS	Basic concepts of the Hydrological Cycle; Processes in the Hydrological Cycle	Prof. Jayawardena, ICHARM	Framework of fundamental equation	Prof. Ishikawa, Tokyo Institute of Technology	Outline of integrated flood risk management (1) R=HxV	Prof. Takeuchi, ICHARM
2	International cooperation in disaster mitigation	Mr. Ishiwatari, JICA	Social systems against disaster	Prof. Morichi, GRIPS	International activities for disaster mitigation	Prof. Okazaki, GRIPS	Precipitation – Types, measurement and presentation of data	Prof. Jayawardena, ICHARM	Equation for 1-dimention flow	Prof. Ishikawa, Tokyo Institute of Technology	Outline of integrated flood risk management (2) PAR model & Flood disaster indices	Prof. Takeuchi, ICHARM
3	Outline of regional development with residents	Mr. Ishiwatari, JICA	Education on basic knowledge for disasters (1)	Prof. Morichi, GRIPS	Japan's policy making	Prof. Okazaki, GRIPS	Extreme weather, Evaporation and evapo-transpiration; Infiltration	Prof. Jayawardena, ICHARM	Roughness of channel and normal depth	Prof. Ishikawa, Tokyo Institute of Technology	Japanese experiences (1) Chronological changes	Prof. Takeuchi, ICHARM
4	Gender (1)	Ms. Suzuki, JICA	Education on basic knowledge for disasters (2)	Prof. Morichi, GRIPS	Basics of Disaster Risk Management	Prof. Okazaki, GRIPS	Runoff – Components, measurement and estimation of runoff	Prof. Jayawardena, ICHARM	Critical depth, Subcritical flow, Supercritical flow	Prof. Ishikawa, Tokyo Institute of Technology	Japanese experiences (2) Comprehensive flood management	Prof. Takeuchi, ICHARM
5	Gender (2)	Ms. Suzuki, JICA	Lessons from tragedies	Prof. Hitoshi IEDA,The University of Tokyo	Disaster risk management policies in Japan -1	Prof. Okazaki, GRIPS	Peak discharge estimation; Rational Method, Baseflow Separation	Prof. Jayawardena, ICHARM	Quiz		Global trends (1) Impact of climatic change	Prof. Oki, Tokyo Univ.
6	Project Cycle Management (1)	JICA staff	Reliability analysis of transportation network	Prof. Morichi, GRIPS	Disaster risk management policies in Japan -2	Prof. Okazaki, GRIPS	Concept of rainfall excess; Role of infiltration and evaporation	Prof. Jayawardena, ICHARM	Tour of laboratory		Global trends (2) International actions	Prof. Oki, Tokyo Univ.
7	Project Cycle Management (2)	JICA staff	Policy for Transportation Infrastructure	Prof. Morichi, GRIPS	Lessons from Hanshin-Awaji Earthquake Disaster	Prof. Okazaki, GRIPS	Unit Hydrograph Methods I	Prof. Jayawardena, ICHARM	Over flow and jump flow	Prof. Ishikawa, Tokyo Institute of Technology	Basic concepts of IFRM (1) IWRM, IRBM and IFRM	Prof. Takeuchi, ICHARM
8	Project Cycle Management (3)	JICA staff	Policy for road infrastructure	Dr.Shigeki UNJYOU, PWRI	Building regulation	Prof. Okazaki, GRIPS	Unit Hydrograph Methods II	Prof. Jayawardena, ICHARM	Gradually varied flow (1)	Prof. Ishikawa, Tokyo Institute of Technology	Basic concepts of IFRM (2) Components of IFRM	Prof. Takeuchi, ICHARM
9	Project Cycle Management (4)	JICA staff	Policy for port infrastructure	Mr.Hidetoshi KUME, JTERC	Housing safety	Prof. Okazaki, GRIPS	Remote sensing in Hydrology	Mr. Fukami, ICHARM	Gradually varied flow (2)	Prof. Ishikawa, Tokyo Institute of Technology	Early warning	Mr. Fukami, ICHARM
10	Project Cycle Management (5)	JICA staff	Policy for airport infrastructure	Prof. Morichi, GRIPS	Issues of disaster management	Prof. Okazaki, GRIPS	Satellite observation of rainfall (1)	JAXA	Unsteady flow	Prof. Ishikawa, Tokyo Institute of Technology	Disaster education	Mr. Yoshii, CERI
11	Project Cycle Management (6)	JICA staff	Policy for airport infrastructure	Prof. Morichi, GRIPS	Urban development and disaster management	Prof. Okazaki, GRIPS	Satellite observation of rainfall (2)	JAXA	Multi-crossed channel	Prof. Ishikawa, Tokyo Institute of Technology	Flood insurance	Dr. Watabe, TOKIO MARINE & NICHIDO RISK CONSULTING Co.,Ltd
12	Project Cycle Management (7)	JICA staff	Land use and regulations	Prof. Morichi, GRIPS	Community based disaster risk management	Prof. Okazaki, GRIPS	Probability and statistics in hydrology I; IDF curves	Prof. Jayawardena, ICHARM	Junction flow and diversion flow	Prof. Ishikawa, Tokyo Institute of Technology	Effects of forests	Ass. Prof. Onda, Tsukuba Univ.
13	Project Cycle Management (8)	JICA staff	Policy Making Process	Prof. Morichi, GRIPS	Practical risk assessment I	Prof. Okazaki, GRIPS	Probability and statistics in hydrology II; Extreme value distribution	Prof. Jayawardena, ICHARM	Retarding basin	Prof. Ishikawa, Tokyo Institute of Technology	Project assessment (1)	Dr. Wakigawa, JICE
14	Project Cycle Management (9)	JICA staff	Presentation by students and discussion (1)	Prof. Morichi, GRIPS	Practical risk assessment II	Prof. Okazaki, GRIPS	Basic concepts of Stochastic Hydrology	Prof. Jayawardena, ICHARM	Curved area and bar	Prof. Ishikawa, Tokyo Institute of Technology	Project assessment (2)	Dr. Wakigawa, JICE
15	Project Cycle Management (10)	JICA staff	Presentation by students and discussion (2)	Prof. Morichi, GRIPS	Special lecture		Examination		Examination		Examination	

Lecture	Local Disaster Management and Hazard Mapping		Advanced Hydrology		Flood Hydraulics and Sediment Transport		Sustainable Reservoir Development & Management		Control Measures for Landslide & Debris Flow	
Number	DMP283E		DMP380E		DMP381E		DMP382E		DMP383E	
Lecturer	Prof. Shigenobu Tanaka		Prof. Amithirigala Widhanelage JAYAWARDENA		Prof. Shoji FUKUOKA		Prof. Norihisa Matsumoto		Prof. Shun Okubo	
Period	Fall through Winter		Fall through Winter		Fall through Winter		Fall through Winter		Fall through Winter	
	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer
1	Outline of Flood Hazard Map	Prof. Tanaka, ICHARM	Hydrological modelling – basic concepts and approaches	Prof. Jayawardena, ICHARM	Outline of rivers in Japan	Prof. Fukuoka, Chuo Univ	Outline of Dam Engineering	Dr. Sakamoto, PWRI	Outline of sediment-related disasters	Prof. Okubo, Japan Sabo Association
2	Geomorphology around Rivers and alluvial plain(1)	Prof. Umitsu, Nagoya Univ.	Systems theory approach I – Linear theory; Time domain analysis; Frequency domain analysis	Prof. Jayawardena, ICHARM	Steady quasi-two dimensional analysis of Flood flow (1)	Prof. Fukuoka, Chuo Univ	Flood Control Plan	Mr. Hakoishi, PWRI	Introduction to sabo projects	Prof. Okubo, Japan Sabo Association
3	Geomorphology around Rivers and alluvial plain(2)	Prof. Umitsu, Nagoya Univ.	Systems theory approach II – Non-linear systems, multi-linear systems	Prof. Jayawardena, ICHARM	Steady quasi-two dimensional analysis of Flood flow (2)	Prof. Fukuoka, Chuo Univ	Flood Control Operation	Mr. Hakoishi, PWRI	Countermeasures for sediment-related disasters	Prof. Ishikawa, Tokyo University of Agriculture & Technology
4	Legislation and Institution concerning to FHM	Prof. Tanaka, ICHARM	Instantaneous Unit Hydrograph (IUH)	Prof. Jayawardena, ICHARM	Unsteady quasi-two-dimensional analysis of flood flows(1)	Prof. Fukuoka, Chuo Univ	Seismic Design for Dams	Prof. Kawasaki, NILIM	Hazard mapping for sediment-related disasters	Dr. Takanashi, Asia Air Survey CO.,LTD
5	Disaster management in administration and organization	Prof. Tanaka, ICHARM	Conceptual models of IUH	Prof. Jayawardena, ICHARM	Unsteady quasi-two-dimensional analysis of flood flows(2)	Prof. Fukuoka, Chuo Univ	Latest Technology for Concrete Dam (1)	Prof. Kawasaki, NILIM	Comprehensive sediment-related disaster measures	Prof. Okubo, Japan Sabo Association
6	Local Disaster Management Plan and Evacuation Planning	Prof. Tanaka, ICHARM	Synthetic Unit Hydrograph	Prof. Jayawardena, ICHARM	Prediction method of flow resistance in rivers with compound channels and application to river course design(1)	Prof. Fukuoka, Chuo Univ	Latest Technology for Concrete Dam (2)	Prof. Kawasaki, NILIM	Countermeasures for earthquake-induced natural dams	Dr. Osanai, NILIM
7	Human Behavior and social psychology	Prof. Hayashi, Kyoto Univ.	Rainfall-runoff modelling I – Conceptual type	Prof. Jayawardena, ICHARM	Prediction method of flow resistance in rivers with compound channels and application to river course design(2)	Prof. Fukuoka, Chuo Univ	Environmental Impact of Dams (1)	Dr. Amano, PWRI	Sabo works in arid area and reforestation of degraded lands	Dr. Ikeya, SABO Technical Center
8	Flood Hazard Map around the World	UNESCO-IHE	Rainfall-runoff modelling II – Physics-based type	Prof. Jayawardena, ICHARM	Predicting flood flow and bed variation from changes in the sediment environment — Practical issues and research directions (1)	Prof. Fukuoka, Chuo Univ	Environmental Impact of Dams (2)	Ass.Prof.Sumi, Kyoto Univ.	Volcanic sabo works	Ass. Prof. Yamada, Mie Univ.
9	Inundation analysis(1)	Dr. Osti, Researcher, ICHARM	Rainfall-runoff modelling III – Data driven type	Prof. Jayawardena, ICHARM	Predicting flood flow and bed variation from changes in the sediment environment — Practical issues and research directions (2)	Prof. Fukuoka, Chuo Univ	Sediment Management in Reservoirs (1)	Ass.Prof.Sumi, Kyoto Univ.	Application of sabo works and landslide countermeasures to overseas countries	Mr. Watanabe, Institute for International Development, Disaster Prevention and Peace Inc.
10	Inundation analysis(2)	Dr. Osti, Researcher, ICHARM	Flood routing – Muskingam method; Muskingam-Cunge method	Prof. Jayawardena, ICHARM	1-D Bed Deformation Computing Model	Prof. Watanabe, Kitami Institute of Technology	Sediment Management in Reservoirs (2)	Ass.Prof.Sumi, Kyoto Univ.	Introduction of landslides	Mr. Yoshimatsu, Institute of Slope Technology
11	Inundation analysis(3)	Dr. Osti, Researcher, ICHARM	Kalman Filtering	Prof. Jayawardena, ICHARM	2-D Bed Deformation Sand Waves and Bars, Meandering	Prof. Watanabe, Kitami Institute of Technology	Dam Construction (1)	Dr. Yamaguchi, PWRI	Characteristics and topography of landslides	Mr. Kasai, PWRI
12	Emergency operation and rehabilitation	Mr. Kamei, Vice Mayor of Ise	Frequency analysis	Prof. Jayawardena, ICHARM	Vegetation Flow in Vegetated Zone	Prof. Watanabe, Kitami Institute of Technology	Dam Construction (2)	Mr. Takasu, Dam Center	Stability analysis for landslide	Dr. Tsunaki, SABO Technical Center
13	Discussion on how to make FHM	Prof. Tanaka, ICHARM	Parameter estimation	Prof. Jayawardena, ICHARM	River restoration based on sediment transport and vegetation on stabilized bars	Prof. Watanabe, Kitami Institute of Technology	Dam Management	Dr. Yamaguchi, PWRI	Survey and emergency response for landslide	Dr. Fujisawa, PWRI
14	Discussion on how to use FHM	Prof. Tanaka, ICHARM	Errors in frequency analysis	Prof. Jayawardena, ICHARM	Re-meandering project for river restoration	Prof. Watanabe, Kitami Institute of Technology	Effective Use of Existing Dams	Prof. Matsumoto, Japan Dam Engineering Center	Maintenance measures for roads and reservoirs in landslide areas	Dr. Fujisawa, PWRI
15	Examination		Examination		Bank erosion and drift woods	Prof. Watanabe, Kitami Institute of Technology	Roles of Dams in 21st Century	Prof. Matsumoto, Japan Dam Engineering Center	Permanent measures for landslide damage reduction	Mr. Ishida, PWRI

2008-2009 Disaster Management Policy Program (Water-related Risk Management Course)　Elective Course

Lecture	Computer Programming		Practice on Hydraulics		Practice on Inundation Analysis		Practice on Hazard Mapping	
Number	DMP180E		DMP284E		DMP285E		DMP286E	
Lecturer	Prof. Shigenobu Tanaka		Prof. Tadaharu Ishikawa		Prof. Shigenobu TANAKA		Prof. Shigenobu TANAKA	
Period	Fall through Winter		Fall through Spring		Fall through Winter		Fall through Winter	
	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer	Lecture	Lecturer
1	Programming Language (1)	Dr. Hai & Dr. Rajapakse, ICHARM	Framework of fundamental equation	Dr. Yorozuya, ICHARM	GIS (1)	Dr. Magome & Dr. Dinar, ICHARM	Town Watching(Field survey and interview) (1)	ICHARM staff
2	Programming Language (2)	Dr. Hai & Dr. Rajapakse, ICHARM	Equation for 1-dimention flow	Dr. Yorozuya, ICHARM	GIS (2)	Dr. Magome & Dr. Dinar, ICHARM	Town Watching(Field survey and interview) (2)	ICHARM staff
3	Programming Language (3)	Dr. Hai & Dr. Rajapakse, ICHARM	Roughness of channel and normal depth	Dr. Yorozuya, ICHARM	GIS (3)	Dr. Magome & Dr. Dinar, ICHARM	Town Watching(Field survey and interview) (3)	ICHARM staff
4	Programming Language (4)	Dr. Hai & Dr. Rajapakse, ICHARM	Critical depth, Subcritical flow, Supercritical flow (1)	Dr. Yorozuya, ICHARM	GIS (4)	Dr. Magome & Dr. Dinar, ICHARM	Town Watching(Field survey and interview) (4)	ICHARM staff
5	Programming Language (5)	Dr. Hai & Dr. Rajapakse, ICHARM	Critical depth, Subcritical flow, Supercritical flow (2)	Dr. Yorozuya, ICHARM	GIS (5)	Dr. Magome & Dr. Dinar, ICHARM	Town Watching(Field survey and interview) (5)	ICHARM staff
6	Numerical Computation (1)	Dr. Hai & Dr. Rajapakse, ICHARM	Over flow and jump flow (1)	Dr. Yorozuya, ICHARM	GIS (6)	Dr. Magome & Dr. Dinar, ICHARM	Town Watching(Field survey and interview) (6)	ICHARM staff
7	Numerical Computation (2)	Dr. Hai & Dr. Rajapakse, ICHARM	Over flow and jump flow (2)	Dr. Yorozuya, ICHARM	GIS (7)	Dr. Magome & Dr. Dinar, ICHARM	Town Watching(Field survey and interview) (7)	ICHARM staff
8	Numerical Computation (3)	Dr. Hai & Dr. Rajapakse, ICHARM	Gradually varied flow (1)	Dr. Yorozuya, ICHARM	Inundation analysis (1)	Dr. Osti, ICHARM	Evacuation Planning (1)	ICHARM staff
9	Numerical Computation (4)	Dr. Hai & Dr. Rajapakse, ICHARM	Gradually varied flow (2)	Dr. Yorozuya, ICHARM	Inundation analysis (2)	Dr. Osti, ICHARM	Evacuation Planning (2)	ICHARM staff
10	Numerical Computation (5)	Dr. Hai & Dr. Rajapakse, ICHARM	Gradually varied flow (3)	Dr. Yorozuya, ICHARM	Inundation analysis (3)	Dr. Osti, ICHARM	Preparing Teaching Material (1)	ICHARM staff
11	Numerical Computation (6)	Dr. Hai & Dr. Rajapakse, ICHARM	Unsteady flow (1)	Dr. Yorozuya, ICHARM	Inundation analysis (4)	Dr. Osti, ICHARM	Preparing Teaching Material (2)	ICHARM staff
12	Numerical Computation (7)	Dr. Hai & Dr. Rajapakse, ICHARM	Unsteady flow (2)	Dr. Yorozuya, ICHARM	Inundation analysis (5)	Dr. Osti, ICHARM	Preparing Teaching Material (3)	ICHARM staff
13	Numerical Computation (8)	Dr. Hai & Dr. Rajapakse, ICHARM	Multi-crossed channel (1)	Dr. Yorozuya, ICHARM	Inundation analysis (6)	Dr. Osti, ICHARM	Preparing Teaching Material (4)	ICHARM staff
14	Numerical Computation (9)	Dr. Hai & Dr. Rajapakse, ICHARM	Multi-crossed channel (2)	Dr. Yorozuya, ICHARM	Inundation analysis (7)	Dr. Osti, ICHARM	Preparing Teaching Material (5)	ICHARM staff
15	Numerical Computation (10)	Dr. Hai & Dr. Rajapakse, ICHARM	Junction flow and diversion flow	Dr. Yorozuya, ICHARM	Inundation analysis (8)	Dr. Osti, ICHARM	Preparing Teaching Material (6)	ICHARM staff

Lecture	Practice on Advanced Hydrology		Practice on River Training		Practice on Sustainable Reservoir Development & Management			Practice on Control Measures for Landslide & Debris Flow		
Number	DMP384E		DMP385E		DMP386E			DMP387E		
Lecturer	Prof. Amithirigala Widhanelage JAYAWARDENA		Prof. Shoji FUKUOKA		Prof. Norihisa Matsumoto			Prof. Shun Okubo		
Period	Fall through Spring		Fall through Spring		Fall through Spring			Fall through Spring		
	Lecture	Lecturer	Lecture	Lecturer	Lecture	Contents	Lecturer	Lecture	Contents	Lecturer
1	Exercises on System function estimation	ICHARM staff	Practice on River Planning (1)	ICHARM staff	On-sight Survey for Dam Construction Site (Isawa Dam)	Project Planning	Isawa Dam Construction Work Office, MLIT	On-sight Survey for Sabo/Landslide Projects	On-sight Survey for River System Sabo: Joganji-gawa River	Tateyama Sabo Office, MLIT
2	Exercises on least squares estimation	ICHARM staff	Practice on River Planning (2)	ICHARM staff		Environmental Assessment and conservation measuers				
3	Exercises on Impulse and Frequency Response Functions	ICHARM staff	Practice on River Planning (3)	ICHARM staff		Countermeasures in Water Resource Area				
4	Exercises on IUH determination	ICHARM staff	Practice on River Planning (4)	ICHARM staff		Dam Construction (1)				
5	Exercises on IUH application	ICHARM staff	Practice on River Planning (5)	ICHARM staff		Dam Construction (2)			On-sight Survey for Earthquake Sabo: Imogawa River	Yuzawa Sabo Office, MLIT
6	Exercises on a typical rainfall-runoff model I	ICHARM staff	River Training (1)	ICHARM staff	Field Survey on Dam Administration (Kawaji Dam, Ikari Dam)	Dam Management	Kinugawa Integrated Dam Control Office, MLIT			
7	Exercises on a typical rainfall-runoff model II	ICHARM staff	River Training (2)	ICHARM staff		Flood Control Operation			On-sight Survey for Degraded land Afforestation/Reforestation : Hillside Works at Mt. Ohnagi	Nikko Sabo Office, MLIT
8	Exercises on flood routing	ICHARM staff	River Training (3)	ICHARM staff		Environmental Impact				
9	Exercises on Kalman filtering I	ICHARM staff	River Training (4)	ICHARM staff		Effective Use of Existing Dans			On-sight Survey for Degraded land Afforestation/Reforestation: Hillside Works at Mt. Ashio	Watarase River Office
10	Exercises on Kalman filtering II	ICHARM staff	Field Survey (1)	Mr. Imbe, Association for Rainwater Storage and Infiltration Technology	Practice on Dam Design	Practice on Design (1)		Training of Development of Procedures for Sediment Disaster Warning and Evacuation	Sediment Hazard Mapping Training (1)	Mr. Takanashi, Sabo Frontier Foundation
11	Exercises on Frequency analysis I	ICHARM staff	Field Survey (2)	Mr. Imbe, Association for Rainwater Storage and Infiltration Technology		Practice on Design (2)			Sediment Hazard Mapping Training (2)	Mr. Takanashi, Sabo Frontier Foundation
12	Exercises on Frequency analysis II	ICHARM staff	Field Survey (3)	ICHARM staff		Practice on Design (3)	Mr. Sakurai, PWRI		Sediment Hazard Mapping Training (3)	Mr. Takanashi, Sabo Frontier Foundation
13	Exercises on Frequency analysis III	ICHARM staff	Field Survey (4)	ICHARM staff		Practice on Design (4)	Mr. Sakurai, PWRI		Sediment Hazard Mapping Training (4)	Mr. Takanashi, Sabo Frontier Foundation
14	Exercises on parameter estimation	ICHARM staff	Field Survey (5)	ICHARM staff	Application for other countries	Application of dam projects for other countries	Dr. Matsumoto,Japan Dam Engineering Center Dr. Yamaguchi, PWRI	Application of Sabo/Landslide Projects to Overseas Countries	Application of sabo/landslide projects for other countries	Dr. Ikeya, SABO Technical Center Mr. Nishimoto, NILIM Mr. Terada, PWRI
15	Exercises on error analysis	ICHARM staff	Field Survey (6)	ICHARM staff						

参考資料 3-3　講義シラバス

Subject Disaster Mitigation Policy

Course number：DMP200E
Instructor：Prof. Shigeru Morichi
Term / Time：Winter

1. Course Description

This course provides the framework of seismic and water related disaster mitigation policies and the basic idea of each policy. The policies discussed in this class include the disaster prevention policies for transportation infrastructure and land-use and also social education for disasters.

2. Course Outline (Course Topics)

1: Introduction: Coverage of this class
Disaster mitigation policy
2: Social systems against disaster
3: Education on basic knowledge for disasters (1)
4: Education on basic knowledge for disasters (2)
5: Lessons from tragedies -By Prof. Hitoshi IEDA,The University of Tokyo
6: Reliability analysis of transportation network
7-11: Policy for Transportation Infrastructure
- Policy for road infrastructure -
Dr.Shigeki UNJYOU, Institute of Public Works
- Policy for port infrastructure - By Mr.Hidetoshi KUME, JTERC
- Policy for airport infrastructure
12: Land use and regulations
13: Policy Making Process
14&15: Presentation by students and discussion
-The improvement of policies in each country

3. Evaluation

Discussion in the class and the town paper are evaluated.

4. Grading

-Class participation (Discussion)	40%
-Term Paper	60%

5. Textbooks

Hand outs and power-point materials

Subject Disaster Risk Management

Course number：DMP201E
Instructor：Prof. Kenji Okazaki
Term / Time：Winter

1. Course Description

This course aims to provide a broad understanding of disaster risk management, including prevention and preparedness before disasters and recovery/reconstruction after disasters. It emphasizes application of appropriate and practical technology, reflecting social and economic conditions of the country. This course attempts to discuss the following issues;

- Activities of national/local governments, international organizations, and communities against disasters
- Issues of disaster management and lessons from the past disasters
- Policies and regulation to secure safety of housing and buildings
- Practical urban risk assessment
- Institutionalization of disaster risk management at various levels

2. Course Outline (Course Topics)

1: Introduction: Disasters in the world
2: International activities for disaster mitigation
3: Japan's policy making
4: Basics of Disaster Risk Management
5: Disaster risk management policies in Japan -1
6: Disaster risk management policies in Japan -2
7: Lessons from Hanshin-Awaji Earthquake Disaster
8: Building regulation
9: Housing safety
10: Issues of disaster management
11: Urban development and disaster management
12: Community based disaster risk management
13: Practical risk assessment I
14: Practical risk assessment II
15: Special lecture

3. Grading

Class participation (40%)
Final examination (60%)

4. Textbooks

None. Handouts and power-point materials will be provided in each class

Subject　Computer Programming

Course number：DMP180E
Instructor：Mr. Shigenobu Tanaka
Term / Time：Fall through Winter

1　Course Description

This course provides general knowledge on computer programming and its skills for computation solving water-related problems covered in Course No. DMP280E “Basic Hydrology”, No. DMP380E “Advanced Hydrology”, No. DMP281E “Hydraulics” and No. DMP283E “Local Disaster Management and Hazard Mapping”.

2　Course Outline (Course Topics)

Week
1 : Programming Language (1)
2 : Programming Language (2)
3 : Programming Language (3)
4 : Programming Language (4)
5 : Programming Language (5)
6 : Numerical Computation (1)
7 : Numerical Computation (2)
8 : Numerical Computation (3)
9 : Numerical Computation (4)
10 : Numerical Computation (5)
11 : Numerical Computation (6)
12 : Numerical Computation (7)
13 : Numerical Computation (8)
14 : Numerical Computation (9)
15 : Numerical Computation (10)

3　Grading

Reports (80%), Final Exam (20%)

If a report is late for the deadline, it will be not evaluated.

4　Textbooks

4-1 Required

4-2 Others

Subject　Introduction to International Cooperation

Course number：DMP181E
Instructor：Mr. Mikio Ishiwatari
Term / Time：Fall through Winter

1　Course Description

This course provides the basic knowledge on international cooperation: players, objectives, target people and implementation mechanism. Japan International Cooperation Agency (JICA) experiences on disaster mitigation and regional development, especially on working together with local community will be the central focus of the lecture. It also covers the subjects of human security in disaster mitigation, regional development with residents and gender. This lecture will orient the students how to think their water-related problems in view of “project cycle management”.

2　Course Outline (Course Topics)

Week

1 ：International activities by JICA
2 ：International cooperation in disaster mitigation
3 ：Outline of regional development with residents
4 ：Gender (1)
5 ：Gender (2)
6 ：Project Cycle Management (1)
7 ：Project Cycle Management (2)
8 ：Project Cycle Management (3)
9 ：Project Cycle Management (4)
10 ：Project Cycle Management (5)
11 ：Project Cycle Management (6)
12 ：Project Cycle Management (7)
13 ：Project Cycle Management (8)
14 ：Project Cycle Management (9)
15 ：Project Cycle Management (10)

3　Grading

Active participation (30%), Reports(40%), Final Examination(30%)

4　Textbooks

4-1 Required

4-2 Others

Subject : Basic Hydrology

Course number：DMP280E
Instructor：A. W. Jayawardena
Term / Time：Fall through Winter

1 Course Description

The aim of this course is to introduce and expose the students to the basic concepts of hydrology including the different processes, quantification of hydrological variables and their measurement and/or estimation, unit hydrograph methods and the application of probability and statistics in hydrology

2 Course Outline (Course Topics)

Week

1 : Basic concepts of the Hydrological Cycle; Processes in the Hydrological Cycle
2 : Precipitation – Types, measurement and presentation of data
3 : Extreme weather – cyclones, typhoons, hurricanes
Evaporation and evapo-transpiration; Infiltration
4 : Runoff – Components, measurement and estimation of runoff
5 : Peak discharge estimation; Rational Method, Baseflow Separation
6 : Concept of rainfall excess; Role of infiltration and evaporation
7 : Unit Hydrograph Methods I
8 : Unit Hydrograph Methods II
9 : Remote sensing in Hydrology (FUKAMI)
10 : Satellite observation of rainfall (JAXA)
11 : Satellite observation of rainfall (JAXA)
12 : Probability and statistics in hydrology I; IDF curves
13 : Probability and statistics in hydrology II; Extreme value distribution
14 : Basic concepts of Stochastic Hydrology
15 : Examination

3 Grading

60% by examination; 40% by in-course assessment

4 Textbooks

4-1 Required

4-2 Others

References (selected)

Linsley, R. K., Kohler, M.A. and Paulhus, J.L.H. (1988): Hydrology for Engineers, SI Metric Edition), McGraw-Hill Book Company

Raudkivi, A. J. (1979): Hydrology – An Advanced Introduction to Hydrological Processes and Modelling, Pergamon Press.

Shaw, E. M. (1983) Hydrology in Practice, Van Nostrand Reinhold (UK)

Singh, V. P. (1992): Elementary Hydrology, Prentice Hall

Viessman, W., Lewis, G. L. and knapp, J.W. (1989): Introduction to Hydrology (Third Edition), Harper Row, Publishers.

Wanielista, M., Kersten, R. and Eaglin, R. (1997): Hydrology: Water quantity and quality control, Second Edition, John Wiley & Sons Inc.

Course Lecture Notes

Subject　Hydraulics

Course number：DMP281E
Instructor：Prof. Tadaharu Ishikawa
Term / Time：Fall through Winter

1　Course Description

This course provides the hydraulic engineering basis for the water-related risk management. It covers the fundamental concepts of open channel hydraulics including the equation for one-dimensional flow, roughness of channel and normal depth, critical depth, subcritical flow, supercritical flow, over flow and jump flow, gradually varied flow, unsteady flow, multi-crossed channel. Students are expected to become able to calculate the flood wave propagation in a real river.

2　Course Outline (Course Topics)

Week

1 : Framework of fundamental equation
2 : Equation for 1-dimention flow
3 : Roughness of channel and normal depth
4 : Critical depth, Subcritical flow, Supercritical flow
5 : Quiz
6 : Tour of laboratory
7 : Over flow and jump flow
8 : Gradually varied flow (1)
9 : Gradually varied flow (2)
10 : Unsteady flow
11 : Multi-crossed channel
12 : Junction flow and diversion flow
13 : Retarding basin
14 : Curved area and bar
15 : Examination

3　Grading

Class participation (30%), Reports (30%), Final Examination(40%)

If a report is late for the deadline, it will be not evaluated.

4　Textbooks

4-1 Required

4-2 Others

Subject　Basic Concepts of Integrated Flood Risk management (IFRM)

Course number：DMP282E
Instructor：Dr. Kuniyoshi Takeuchi
Term / Time：Fall through Winter

1　Course Description

This course provides the basic concepts of “Integrated Flood Risk Management (IFRM)” as the basis of the Master Program of “Water-related Risk Management”. The mechanism of disaster risk occurrence with natural hazard, societal vulnerability, exposure, coping capacity etc. will be emphasized. It also provides the current global and international trend and activities including Japanese flood management experiences and climate change. Then the important components of IFRM will be specifically focused such as disaster education, flood insurance, project assessment etc. Some lectures may be given by internationally renowned experts invited by ICHARM.

2　Course Outline (Course Topics)

Week

１：Outline of integrated flood risk management (1) R=HxV
２：Outline of integrated flood risk management (2) PAR model & Flood disaster indices
３：Japanese experiences (1) Chronological changes
４：Japanese experiences (2) Comprehensive flood management
５：Global trends (1) Impact of climatic change
６：Global trends (2) International actions
７：Basic concepts of IFRM (1) IWRM, IRBM and IFRM
８：Basic concepts of IFRM (2) Components of IFRM
９：Early warning & Emergency responses
１０：Disaster education
１１：Flood insurance
１２：Effects of forests
１３：Project assessment (1)
１４：Project assessment (2)
１５：Examination

3　Grading

Active participation(30%), Reports(40%), Final Examination(30%)

4　Textbooks

4-1 Required

Ben Wisner, Piers Blaikie, Terry Cannon and Ian Davis, At Risk -natural hazards, people’s vulnerability and disasters- (Routledge, London & NY, 2004)

4-2 Others

Subject　Local Disaster Management and Hazard Mapping

Course number：DMP283E
Instructor：Mr. Shigenobu Tanaka
Term / Time：Fall through Winter

1　Course Description

This course provides not only general knowledge on flood hazard maps (FHM) in Japan and the world, but also professional knowledge and techniques which are indispensable for FHM such as inundation analysis. In addition, students will also learn/understand information to be included in FHM, how to disseminate and utilize FHM through town watching (field survey and interviewing).

2　Course Outline (Course Topics)

Week

1：Outline of Flood Hazard Map
2：Geomorphology around Rivers and alluvial plain(1)
3：Geomorphology around Rivers and alluvial plain(2)
4：Legislation and Institution concerning to FHM
5：Disaster management in administration and organization
6：Local Disaster Management Plan and Evacuation Planning
7：Human Behavior and social psychology
8：Flood Hazard Map around the World
9：Inundation analysis(1)
10：Inundation analysis(2)
11：Inundation analysis(3)
12：Emergency operation and rehabilitation
13：Discussion on how to make FHM
14：Discussion on how to use FHM
15：Examination

3　Grading

Active participation (20%), Reports (40%), Final Exam (40%)

If a report is late for the deadline, it will be not evaluated.

4　Textbooks

4-1 Required

4-2 Others

Subject　Practice on Hydraulics

Course number：DMP284E
Instructor：Prof. Tadaharu Ishikawa
Term / Time：Fall through Spring

1　Course Description

This course aims at consolidating the material covered in Course No. DMP281E “Hydraulics”.

Exercises related to each topic will be given to the students and they will be discussed and explained. It also includes field survey.

Students performance at these exercises will be counted toward their grades.

2　Course Outline (Course Topics)

Week

1 ：Framework of fundamental equation
2 ：Equation for 1-dimention flow
3 ：Roughness of channel and normal depth
4 ：Critical depth, Subcritical flow, Supercritical flow (1)
5 ：Critical depth, Subcritical flow, Supercritical flow (2)
6 ：Over flow and jump flow (1)
7 ：Over flow and jump flow (2)
8 ：Gradually varied flow (1)
9 ：Gradually varied flow (2)
10 ：Gradually varied flow (3)
11 ：Unsteady flow (1)
12 ：Unsteady flow (2)
13 ：Multi-crossed channel (1)
14 ：Multi-crossed channel (2)
15 ：Junction flow and diversion flow

3　Grading

Class participation (40%), Reports (60%)

If a report is late for the deadline, it will be not evaluated.

4　Textbooks

4-1 Required

4-2 Others

Subject　Practice on Inundation Analysis

Course number：DMP285E
Instructor：Mr. Shigenobu Tanaka
Term / Time：Fall through Winter

1　Course Description

This course aims at consolidating the material covered in Course No. DMP283E "Local Disaster Management and Hazard Mapping".

Exercises related to Inundation Analysis and Geographic Information System(GIS), which are important techniques in Flood Hazard Mapping, will be given to the students.

2　Course Outline (Course Topics)

Week

1 : GIS (1)
2 : GIS (2)
3 : GIS (3)
4 : GIS (4)
5 : GIS (5)
6 : GIS (6)
7 : GIS (7)
8 : Inundation analysis (1)
9 : Inundation analysis (2)
10 : Inundation analysis (3)
11 : Inundation analysis (4)
12 : Inundation analysis (5)
13 : Inundation analysis (6)
14 : Inundation analysis (7)
15 : Inundation analysis (8)

3　Grading

Reports (70%), Final Exam (30%)

If a report is late for the deadline, it will be not evaluated.

4　Textbooks

4-1 Required

4-2 Others

Subject　Practice on Hazard Mapping

Course number：DMP286E
Instructor：Mr. Shigenobu Tanaka
Term / Time：Fall through Winter

1　Course Description

This course aims at consolidating the material covered in Course No. DMP283E "Local Disaster Management and Hazard Mapping".

Exercises related to each topic will be given to the students and they will be discussed and explained. It also includes field survey.

Students performance at these exercises will be counted toward their grades.

2　Course Outline (Course Topics)

Week

1 : Town Watching(Field survey and interview) (1)
2 : Town Watching(Field survey and interview) (2)
3 : Town Watching(Field survey and interview) (3)
4 : Town Watching(Field survey and interview) (4)
5 : Town Watching(Field survey and interview) (5)
6 : Town Watching(Field survey and interview) (6)
7 : Town Watching(Field survey and interview) (7)
8 : Evacuation Planning (1)
9 : Evacuation Planning (2)
10 : Preparing Teaching Material (1)
11 : Preparing Teaching Material (2)
12 : Preparing Teaching Material (3)
13 : Preparing Teaching Material (4)
14 : Preparing Teaching Material (5)
15 : Preparing Teaching Material (6)

3　Grading

Active participation (30%), Reports (50%), Final Exam (20%)

If a report is late for the deadline, it will be not evaluated.

4　Textbooks

4-1 Required

4-2 Others

Subject : Advanced Hydrology

Course number：DMP380E
Instructor：A. W. Jayawardena
Term / Time：Fall through Winter

1 Course Description

The objective of this course is to provide knowledge and skill in advanced techniques of hydrological data analysis, modelling and prediction

2 Course Outline (Course Topics)
Week
1 : Hydrological modelling – basic concepts and approaches
2 : Systems theory approach I – Linear theory; Time domain analysis; Frequency domain analysis
3 : Systems theory approach II – Non-linear systems, multi-linear systems
4 : Instantaneous Unit Hydrograph (IUH)
5 : Conceptual models of IUH
6 : Synthetic Unit Hydrograph
7 : Rainfall-runoff modelling I – Conceptual type
8 : Rainfall-runoff modelling II – Physics-based type
9 : Rainfall-runoff modelling III – Data driven type
10 : Flood routing – Muskingam method; Muskingam-Cunge method
11 : Kalman Filtering
12 : Frequency analysis
13 : Parameter estimation
14 : Errors in frequency analysis
15 : Examination

3 Grading
60% by examination; 40% by in-course assessment

4 Textbooks
4-1 Required

4-2 Others

Reference books

Battan, L. J. (1984) : Fundamentals of meteorology, Prentice Hall Inc. Englewood Cliffs, New Jersey

Eagleson, P. S: (1970) : Dynamic hydrology, McGraw Hill Book Co.

Kite, G. W. (1977): Frequency and risk analysis in hydrology, Water resources publication, Fort Collins, Colorado.

Lattermann, A. (1991) : System-Theoretical modelling in surface water hydrology, Springer- Verlag.

McCuen, R. M. ((1989) Hydrologic analysis and design, Prentice Hall

Raudkivi, R. J. (1979) : Hydrology - An advanced introduction to hydrological processing and modelling, Pergamon Press

Viessman, W. Lewis, G. L. and Knapp, J. W. (1989): Introduction to hydrology, 3rd Edition, Harper & Row.

Wanielista, M. (1990) : Hydrology and water quality control, John Wiley

Course Lecture Notes

Subject　Flood Hydraulics and Sediment Transport

Course number：DMP381E
Instructor：Prof. Shoji FUKUOKA
Term / Time：Fall through Winter

1　Course Description

This course provides the basic knowledge necessary for selecting and designing the structural measures for IFRM. The course first describes the river administration and planning for application of IFRM. Especially the methodology of comprehensive river management will be emphasized that includes planning of flood control, flood hydraulics and sediment movement to river channels and dam reservoirs. This will be followed by specific technologies of channel control and channel improvement.

2. Course Outline (Course Topics)

Week

1. Outline of rivers in Japan
2. Steady quasi-two dimensional analysis of Flood flow (1)
3. Steady quasi-two dimensional analysis of Flood flow (2)
4. Unsteady quasi-two-dimensional analysis of flood flows(1)
5. Unsteady quasi-two-dimensional analysis of flood flows(2)
6. Prediction method of flow resistance in rivers with compound channels and application to river course design(1)
7. Prediction method of flow resistance in rivers with compound channels and application to river course design(2)
8. Predicting flood flow and bed variation from changes in the sediment environment—Practical issues and research directions (1)
9. Predicting flood flow and bed variation from changes in the sediment environment—Practical issues and research directions (2)
10. 1-D Bed Deformation　Computing Model
11. 2-D Bed Deformation　Sand Waves and Bars, Meandering
12. Vegetation　Flow in Vegetated Zone
13. River restoration based on sediment transport and vegetation on stabilized bars
14. Re-meandering project for river restoration
15. Bank erosion and drift woods

3　Grading

Reports (20%)　Final examination (80%)

4　Textbooks

4-1 Required

4-2 Others

prints made by the instructors

Subject　Sustainable Reservoir Development & Management

Course number：DMP382E
Instructor：Dr. Norihisa Matsumoto
Term / Time：Fall through Winter

1　Course Description

This course provides the basic ideas of dam reservoir design and construction. The lecture starts from the multiple objectives of dam reservoirs and looks into their environmental (including sediments) and societal impacts. The lecture covers the basic methodologies of planning of capacity and site selection, environmental impact assessment, sediment management and operation and maintenance of dam reservoirs. The students are expected to experience a preliminary but concrete process of environmental assessment of reservoirs and gets insight of the role of reservoirs dealing with climate changes.

2　Course Outline (Course Topics)

Week

1．Outline of Dam Engineering
2．Flood Control Plan
3．Flood Control Operation
4．Seismic Design for Dams
5．Latest Technology for Concrete Dam (1)
6．Latest Technology for Concrete Dam (2)
7．Environmental Impact of Dams (1)
8．Environmental Impact of Dams (2)
9．Sediment Management in Reservoirs (1)
10．Sediment Management in Reservoirs (2)
11．Dam Construction (1)
12．Dam Construction (2)
13．Dam Management
14．Effective Use of Existing Dams
15．Roles of Dams in 21st Century

3　Grading

Class participation　60%,　Reports 40%

If you miss the deadline for reports, your reports will only be evaluated for a certain percentage of what they are supposed to be:

Up to seven days: 70%

Eight days or longer: 50%

4　Textbooks

4-1 Required

4-2 Others

Subject　Control Measures for Landslide & Debris Flow

Course number：DPM 383E
Instructor：Dr. Shun Okubo
Term / Time：Fall through Winter

1　Course Description

This course provides the necessary knowledge and understanding of landslide and debris flow phenomena and their control measures necessary to exercise the IFRM. The lecture will illustrate the devastating phenomena and the causes of landslides and debris flows and provide the basic concepts of sabo works which control both hill slopes and channels. It will cover the important role of hazard mapping for sediment-related disasters in both structural and non-structural measures.

2　Course Outline (Course Topics)

Week

1．Outline of sediment-related disasters
2．Introduction to sabo projects
3．Countermeasures for sediment-related disasters
4．Hazard mapping for sediment-related disasters
5．Comprehensive sediment-related disaster measures
6．Countermeasures for earthquake-induced natural dams
7．Sabo works in arid area and reforestation of degraded lands
8．Volcanic sabo works
9．Application of sabo works and landslide countermeasures to overseas countries
10．Introduction of landslides
11．Characteristics and topography of landslides
12．Stability analysis for landslide
13．Survey and emergency response for landslide
14．Maintenance measures for roads and reservoirs in landslide areas
15．Permanent measures for landslide damage reduction

3　Grading

Class participation (30%) A Report and Final examination (70%)

4　Textbooks

4-1 Required

4-2 Others

Subject : Practice on Advanced Hydrology

Course number：DMP384E
Instructor：A. W. Jayawardena
Term / Time：Fall through Spring

1 Course Description

The objective of this course is to train the students in various quantitative methods in Hydrology including some exercises on hydrological data analysis, modeling and prediction.

2 Course Outline (Course Topics)
Week
1 : Exercises on System function estimation
2 : Exercises on least squares estimation
3 : Exercises on Impulse and Frequency Response Functions
4 : Exercises on IUH determination
5 : Exercises on IUH application
6 : Exercises on a typical rainfall-runoff model I
7 : Exercises on a typical rainfall-runoff model II
8 : Exercises on flood routing
9 : Exercises on Kalman filtering I
10 : Exercises on Kalman filtering II
11 : Exercises on Frequency analysis I
12 : Exercises on Frequency analysis II
13 : Exercises on Frequency analysis III
14 : Exercises on parameter estimation
15 : Exercises on error analysis

3 Grading

100% in-course assessment

4 Textbooks
4-1 Required

4-2 Others

Subject　Practice on River Training

Course number：DMP385E
Instructor：Prof. Shoji FUKUOKA
Term / Time：Fall through Spring

1　Course Description

This course aims at consolidating the material covered in Course No. DMP381E "Flood Hydraulics and Sediment Transport".

Exercises related to each topic will be given to the students and they will be discussed and explained. It also includes field survey.

Students performance at these exercises will be counted toward their grades.

2　Course Outline (Course Topics)

Week

1 : Practice on River Planning (1)
2 : Practice on River Planning (2)
3 : Practice on River Planning (3)
4 : Practice on River Planning (4)
5 : Practice on River Planning (5)
6 : River Training (1)
7 : River Training (2)
8 : River Training (3)
9 : River Training (4)
10 : Field Survey (1)
11 : Field Survey (2)
12 : Field Survey (3)
13 : Field Survey (4)
14 : Field Survey (5)
15 : Field Survey (6)

3　Grading

Class participation(40%), Reports(60%)

4　Textbooks

4-1 Required

4-2 Others

Subject　Practice on Sustainable Reservoir Development & Management

Course number：DMP386E
Instructor：Dr. Norihisa Matsumoto
Term / Time：Fall through Spring

1　Course Description

This course aims at consolidating the material covered in Course No. DMP382E "Sustainable Reservoir Development & Management".

Exercises related to each topic will be given to the students and they will be discussed and explained. It also includes field survey.

Students performance at these exercises will be counted toward their grades.

2　Course Outline (Course Topics)

Week

1．On-sight Survey for Dam Construction Site (Isawa Dam) (1)
2．On-sight Survey for Dam Construction Site (Isawa Dam) (2)
3．On-sight Survey for Dam Construction Site (Isawa Dam) (3)
4．On-sight Survey for Dam Construction Site (Isawa Dam) (4)
5．On-sight Survey for Dam Construction Site (Isawa Dam) (5)
6．Field Survey on Dam Administration (Kawaji Dam, Ikari Dam) (1)
7．Field Survey on Dam Administration (Kawaji Dam, Ikari Dam) (2)
8．Field Survey on Dam Administration (Kawaji Dam, Ikari Dam) (3)
9．Field Survey on Dam Administration (Kawaji Dam, Ikari Dam) (4)
10．Practice on Dam Design (1)
11．Practice on Dam Design (2)
12．Practice on Dam Design (3)
13．Practice on Dam Design (4)
14．Application for other countries (1)
15．Application for other countries (2)

3　Grading

Class participation　70%,　Reports 30%

If you miss the deadline for reports, your reports will only be evaluated for a certain percentage of what they are supposed to be:

Up to seven days: 70%

Eight days or longer: 50%

4　Textbooks

4-1 Required

4-2 Others

Subject　Practice on Control Measures for Landslide & Debris Flow

Course number：DMP387E
Instructor：Dr. Shun Okubo
Term / Time：Fall through Spring

1　Course Description

This course aims at consolidating the material covered in Course No. DMP383E "Control Measures for Landslide & Debris Flow".

Exercises related to each topic will be given to the students and they will be discussed and explained. It also includes field survey.

Students performance at these exercises will be counted toward their grades.

2　Course Outline (Course Topics)

Week

1．On-sight Survey for Sabo/Landslide Projects (1)
2．On-sight Survey for Sabo/Landslide Projects (2)
3．On-sight Survey for Sabo/Landslide Projects (3)
4．On-sight Survey for Sabo/Landslide Projects (4)
5．On-sight Survey for Sabo/Landslide Projects (5)
6．On-sight Survey for Sabo/Landslide Projects (6)
7．On-sight Survey for Sabo/Landslide Projects (7)
8．On-sight Survey for Sabo/Landslide Projects (8)
9．On-sight Survey for Sabo/Landslide Projects (9)
10．Training of Development of Procedures for Sediment Disaster Warning and Evacuation (1)
11．Training of Development of Procedures for Sediment Disaster Warning and Evacuation (2)
12．Training of Development of Procedures for Sediment Disaster Warning and Evacuation (3)
13．Training of Development of Procedures for Sediment Disaster Warning and Evacuation (4)
14．Application of Sabo/Landslide Projects to Overseas Countries (1)
15．Application of Sabo/Landslide Projects to Overseas Countries (2)

3　Grading

Class participation (30%) A Report and Final examination (70%)

4　Textbooks

4-1 Required

4-2 Others

参考資料 3-4　　学位記

National Graduate Institute for Policy Studies

Based on the recommendation of the Faculties of
the National Graduate Institute for Policy Studies, and
the Public Works Research Institute,

the National Graduate Institute for Policy Studies
hereby confers the degree

of

Master of Disaster Management

upon

Maruli Tua Gregorius Simatupang

for having successfully completed all of the requirements of the
Disaster Management Policy Program

on this, the sixteenth day of September, 2009

Tatsuo Hatta
President
National Graduate Institute for Policy Studies

竹内邦良
Director
International Centre for Water Hazard and Risk Management,
Public Works Research Institute

修第1650号

学位記

Maruli Tua Gregorius Simatupang

1981年5月5日生

政策研究大学院大学及び土木研究所が連携して実施する防災政策プログラム(政策研究大学院大学政策研究科修士課程)を修了したので修士(防災政策)の学位を授与する

平成21年9月16日

政策研究大学院大学長 八田達夫

土木研究所
水災害・リスクマネジメント国際センター長 竹内邦良

参考資料 3-5　講師一覧表

List of Lecturers for 2008-2009 Water-related Risk Management Course

	Lecture	Name	Affiliation	Position	Publication	
1	Disaster Management Policy	Shigeru Morichi	National Graduate Institute for Policy Studies (GRIPS)	Professor	Sugawara, M. and Morichi, S., "Feasibility Study of the Rapid Transit of Small Unit for a New Town", Proceedings of 1st International Conference on Transportation Research, 1973	Morichi, S., Ishida, H. and Yai, T., "Comparison of Various Utility Functions for Behavioral Travel Demand Model", Selected Proceedings of 4th World Conference on Transportation Research, pp.159-165, 1983.
2	Disaster Risk Management	Kenji Okazaki	National Graduate Institute for Policy Studies (GRIPS)	Professor	Kenji Okazaki, Tatsuo Narafu, “Housing Reconstruction Practices in Aceh, Indonesia,” 『日本建築学会論文集』2007年9月号、257-262頁（2007年）	Korel Eraybar, Alper Ilki, Kenji Okazaki, “Seismic Risk Perception in Avcilar,” Proceedings of Turkish Sixth National Conference on Earthquake Engineering（16-20 October 2007, Istanbul, Turkey）, Vol.2, pp.41-51（2007年）
3	Introduction to International Cooperation	Mikio Ishiwatari	Japan International Cooperation Agency	Senior Advisor		
4	Computer Programming	Pham Thanh Hai	International Centre for Water Hazard and Risk Management (ICHARM)	Researcher	Pham Thanh Hai, Masumoto T., Shimizu K. (2008) Development of a two-dimensional finite-element model for inundation processes in the Tonle Sap and its environs, Hydrological Processes, pp 1329 - 1336.	Masumoto, T., Pham Thanh Hai, Shimizu K. (2008) Impact of paddy irrigation levels on floods and water use in the Mekong River basin, Hydrological Processes, pp 1321 - 1328.
5		Rajapakse Hemantha	International Centre for Water Hazard and Risk Management (ICHARM)	Researcher	Asaeda, T. & Rajapakse, L., 2008. Effects of spates of different magnitudes on a Phragmites japonica population on a sandbar of a frequently disturbed river. River Research and Applications 24: 1310-1324 (DOI: 10.1002/rra.1128).	Asaeda, T., Rajapakse, L. & Fujino, T., 2008. Applications of organ-specific growth models; modeling of resource translocation and the role of emergent aquatic plants in element cycles. Ecological Modeling 215: 170–179.

6	Bisic Hydrology Advanced Hydrology	Amithirigala Widhanelage JAYAWARDENA	International Centre for Water Hazard and Risk Management (ICHARM)	Research & Training Advisor	N. Muttil and Jayawardena, A. W.(2008): *Shuffled Complex Evolution model calibrating algorithm: enhancing its robustness and efficiency* , Hydrological Processes	Jayawardena, A. W., Xu, P.C. and Li, W. K.(2008): *A method of estimating the noise level in a chaotic time series,* Chaos
7		Kazuhiko Fukami	International Centre for Water Hazard and Risk Management (ICHARM)	Team Leader	Hironori Inomata, Kazuhiko Fukami (2008): *Restoration of historical hydrological data of Tonle Sap Lake and surronding areas,* Hydrological Processes, Vol. 22 Issue 9 1337-1350	Junichi Yoshitani,Kuniyoshi Takeuchi,Kazuhiko Fukami, Tadashi Matsuura (2007): *Toward the application of the physically based distributed hydrological model BTOPMC to ungauged basins* , Proceedings of the PUB Kick-off meeting held in Brasilia, 20-22 November 2002
8	Hydraulics	Tadaharu Ishikawa	Tokyo Institute of Technology	Professor	TADAHARU ISHIKAWA. Study on the hydrological conditions for the conservation of the nesting habitat of the Red-crowned Crane in Xianghai Wetlands, China. Hydrological Processes. Vol. 23. pp. 612-622. 2009	TADAHARU ISHIKAWA. Field Research on Domestic Wastewater from a Slum in Bandung City. Journal of Hydroscience and Hydraulic Engineering. Vol. 26. No. 1. pp. 129-140. 2008 ,May.
9		Atsuhiro Yorozuya	International Centre for Water Hazard and Risk Management (ICHARM)	Researcher	Atsuhiro Yorozuya, Sachio Shintaku, Keizo Ejima, Kazuhiko Fukami, and Hirokatsu Kanazawa (2009), DEVELOPMENT OF A SEDIMENT DISCHARGE MEASUREMENT SYSTEM WITH ADCP, 10th international conference on Fluid control, measurements, and visualization, August 17-21, Moscow, Russia (submitted)	Yorozuya,A.,Fukami,K.,Shibata,N.,Kanno, Y.,and Imamura,H.(2008) : Flow characteristics in actual river based on field observations using ADCP, The Second International Symposium on Shallow Flows(ISSF2008), Hong Kong, 10-12 December, 2008. Abstract on p49; full paper in CD-ROM
10	Integrated Flood Risk Management - IFRM-	Kuniyoshi Takeuchi	International Centre for Water Hazard and Risk Management (ICHARM)	Director	Guoqiang Wang , Prasantha Hapuarachchi, Hiroshi Ishidaira, Anthony S. Kiem, Kuniyoshi Takeuchi (2008): *Estimation of Soil Erosion and Sediment Yield During Individual Rainstorms at Catchment Scale,* Water Resour Manage, DOI 10.1007/s11269-008-9335-8	Kuniyoshi Takeuchi (2008): *Studies on the Mekong River Basin-Modelling of Hydrology and Water Resources* , Hydrological Processes, 22(9), 1243-1245
11		Junichi Yoshitani	International Centre for Water Hazard and Risk Management (ICHARM)	Team Leader	Junichi Yoshitani, AO TIANQI (2007): *Development of a natural flow hydrological database for PUB studies,* Proceedings of the PUB Kick-off meeting held in Brasilia, 20-22 November 2002, 309, 201-207	Tarek Merabtene, Junichi Yoshitani, Assela Pathirana (2006): *Status of Disaster Database and Limitations for Planning* , "Proceedings of the 3rd APHW Conference" "Wise Water Resources Management Towards Sustainable Growth and Poverty Reduction"

12	Katsuhito Miyake	International Centre for Water Hazard and Risk Management (ICHARM)	Team Leader	Water-related Disaster Response System by FEMA, USA (Jul. 1995: Journal of Japan River Association)	Sharing of Experience on Local Actions for Water and Typhoon-related Disaster Risk Reduction (Jun. 2006: Journal of Japan River Association)
13	Atsushi Yoshii	Civil Engineering Research Institute for Cold Region, PWRI	Group Leader	(Only in Japanese)	
14	Hiroyuki Watabe	Tokio Marine & Nichido Risk Consulting Co.,Ltd	Group Leader	(Only in Japanese)	
15	Taikan Oki	Institute of Industrial Science, the University of Tokyo	Professor	M. Lin, T. Holloway, T. Oki, D. G. Streets, and A. Richter, 2009: Multi-scale model analysis of boundary layer ozone over East Asia, Atmos. Chem. Phys., 9, 3277.3301	Seto, S., T. Kubota, T. Iguchi, N. Takahashi, T. Oki, 2009: An evaluation of over-land rain rate estimates by the GSMaP and GPROF algorithms: The role of lower-frequency channels., J. Meteor. Soc. Japan, 87A, 183-202
16	Masahiro Imbe	Association for Rainwater Storage and Infiltation Technology	Executive	A Discussion on Watershed Model Reqirements for Hydrological Cycle Improvement Planning in Japan (2003)	Monitoring and Analysis of Implemented Infiltration System over Pas 20 years (2002)
17	Katsumi Wakigawa	Japan Institute of Construction Engineering	Sub manager	(Only in Japanese)	

18		Yuichi Onda	Institute of Geoscience, University of Tsukuba	Associate Professor	Onda, Y., Dietrich, W.E., Booker, F. (2007): Evolution of overland flow after a severe forest fire, Point Reyes, California. Catena, doi:10.1016/j.catena.2007.02.003	Onda, Y., Kato, H., Tanaka, Y. Tsujimura, M., Davaa, G., and Oyunbaatar, D. (2007): Analysis of runoff generation and soil erosion processes by using environmental radionuclides in semiarid areas of Mongolia. Journal of Hydrology, 333, 124-132. doi:10.1016/j.jhydrol.2006.07.030
19	Flood Hydraulics and Sediment Transport	Shoji Fukuoka	Chuo University	Professor	S. Fukuoka (2008): Keynote Lecture: *Unsteady Quasi-Two-Dimensional Flow Analysis of Flood Flows in a River with Vegetation* , Advances in Hydro-Science and Engineering, Vol.8, ICHE Nagoya,Japan, CD-ROM	S. Fukuoka, T.Abe, Y.Tsukamoto (2008): *Calculation Method of Inundation Discharge Hydrograph from the Temporal Changes in Water Surface Profile Due to Levee Breach* , Advances in Hydro-Science and Engineering Vol.8, ICHE Nagoya,Japan, CD-ROM
20		Shinji Egashira	NEWJEC Inc.	Chief Engineer	Egashira S (2007): Review of research related to sediment disaster mitigation,Jour. Disaster Research, Vol.2, No.2, pp.11-19	Egashira S., Itoh T., Horie K. and Nishimoto N. (2007): A method to predict sediment transport process in drainage basins with dams, River, Coastal and Estualine Morphodynamics, rcem 2007, Taylor & Francis, pp. 1193-1201
21		Yasuharu Watanabe	Kitami Institute of Technology	Professor	(2008) *Basic Hydraulic Characteristic of the Chiyoda Experiment Channel* , River Flow 2008, Page 1805-1813	(2008) Long-term One-dimensional Calculation of Bed Variation for a River Channel with a Compound Cross-Section, River Flow 2008, Page 2169-2179
22		Chavoshian Seyed Ali	International Centre for Water Hazard and Risk Management (ICHARM)	Researcher	Ali Chavoshian (2008): *Hydrological Modeling of Large-scale Ungauged Basin Case Study: Ayeyarwady (Irrawaddy) Basin, Myanmar* , Conference Proceeding, No.7 43-48	Seyed Ali CHAVOSHIAN, Kuniyoshi TAKEUCHI and Susumu FUNADA, An Overview to Transboundary and hareds Water Resources, Proceeding of the International Symposium on Role of Water Science in Transboundary River Basin Management
23	Flood Hazard Mapping & Evacuation Planning	Shigenobu Tanaka	International Centre for Water Hazard and Risk Management (ICHARM)	Team Leader	Goodness-of-fit and stability assessment in flood frequency analysis, JSCE,1999	Hydrologic frequency analysis with annual maximum series and partial duration series, JSCE,1999

24	Masatomo Umitsu	Graduate School of Environmental Studies, Nagoya University	Professor	Umitsu, M., Tanavud, C. and Patanakanog, B. (2007) Effects of landforms on tsunami flow in the plains of Banda Aceh, Indonesia, and Nam Khem, Thailand. Marine geology, 242, 141-153	Hori, K., Kuzumoto, R., Hirouchi, D., Umitsu, M., Janjirawuttikul, N. and Patanakanog, B. (2007) Horizontal and vertical variation of 2004 Indian tsunami deposits:An example of two transects along the western coast of Thailand. Maine Geology, 239, 163-172
25	Meulen Frank	UNESCO Institute for Water Education (IHE)	Professor		
26	Yujiro Ogawa	Fuji Tokoha University	Professor	(Only in Japanese)	
27	Haruo Hayashi	Disaster Prevention Research Institute, Kyoto University	Professor	Haruo HAYASHI, Manabu WATANABE, Masasuke TAKASHIMA, Kouichi HASEGAWA (2004): Deveropmeto of Procedure to Create Building Inventory for seismic Risk Assessment in Developing Countries using IKONOS Satellite Image, 13th World Conference Earthquake Engineering	Tomoko SHAW, Fumio KANEKO, Takashi KOMURA, Shirley MATTINGLY, Haruo HAYASHI (2003) Community-based disaster management activities in the Kathmandu Valley Nepal7US/Japan Workshop on Urban Earthquake Hazard Reduction
28	Hideki Kamei	Ise City, Mie Prefecture	Vice Mayor	(Only in Japanese)	
29	Osti Rabindra	International Centre for Water Hazard and Risk Management (ICHARM)	Researcher	Osti R. & Egashira S. (2008): *Method to improve the mitigative effectiveness of a series of check dams against debris flows* , Hydrological Processes, vol. 22 4986-4996	Osti, R., Shigenobu T. & Tokioka T. (2008): *Flood hazard mapping in developing countries: a prospect and problems* , Disaster Prevention and Management, vol. 17, no.1 104-113

30		Jun Magome	International Centre for Water Hazard and Risk Management (ICHARM)	Researcher	Effects of the Novel Scaling Algorithm of River Networks on Discharge Simulations, Keiichi MASUTANI and Jun MAGOME, Journal of Japan Society of Hydrology and Water Resources,Vol.21, No.3, pp.242-247, 2008.5	A BTOP model to extend TOPMODEL for distributed hydrological simulation of large basins, Kuniyoshi Takeuchi, Prasantha Hapuarachchi, Maichun Zhou, Hiroshi Ishidaira and Jun Magome, Hydrological Processes, Vol.22, Issue 17, pp. 3236-3251, 2008.8
31	Sustainable Reservoir Development & Management	Norihisa Matsumoto	Japan Dam Engineering Center	Advisor	(Only in Japanese)	
32		Tadahiko Sakamoto	Public Works Research Institute	Chief Executive	(Only in Japanese)	
33		Hitoshi Umino	Hydraulic Engineering Research Group, Public Works Research Institute	Senior Researcher	(Only in Japanese)	
34		Hideaki Kawasaki	National Institute for Land and Infrastructure Management (NILIM)	Chief Researcher	(Only in Japanese)	
35		Kunihiko Amano	Water Environment Research Group, Public Works Research Institute	Team Leader	K.Nakamura, G.Mueller(2008.5)：Review of the performance of the artificial folating island as a restoration tool for aquatic environments, World Environmental & Water Resources Congress 2008, the American Society of Civil Engineers Environmental and Water Resources Institute	Kunihiko Amano, Tetsuya Oishi, Toshikazu Tokioka(2008.5)：Restoration attempt of submerged macrophytes in an eutrophic shallow lake in Japan, World Environmental & Water Resources Congress 2008, the American Society of Civil Engineers Environmental and Water Resources Institute

36		Tetsuya Sumi	Graduate School of Management, Kyoto University	Associate Professor	Environmental Study on Sediment Flushing in the Kurobe River, 22nd ICOLD, Barcelona, Q.85-R.16, 2006	Reservoir Sedimentation Management with Bypass Tunnels in Japan, 9th ISRS, Ⅱ, 1036-1043, 2004
37		Yoshikazu Yamaguchi	Hydraulic Engineering Research Group, Public Works Research Institute	Team Leader	(Only in Japanese)	
38		Syuji Takasu	Japan Dam Engineering Center	Executive	(Only in Japanese)	
39		Toshiyuki Sakurai	Hydraulic Engineering Research Group, Public Works Research Institute	Senior Researcher	(Only in Japanese)	
40	Control Measures for Landslide & Debris Flow	Shun Okubo	Japan Sabo Association	Chief Executive	Comprehensive Measures-Specifically Non-Structural Measures-against Sediment Related Disasters in Japan, ACECC Forum on Sustainable Development (2003)	Ecological Measures for Hillside, Torrent Control Works and Road Works in Japan, 2006 International Symposium on Ecological Engineering (2006)
41		Yoshiharu Ishikawa	Tokyo University of Agriculture and Technology	Professor	(Only in Japanese)	

42	Kazuyuki Takanashi	Asia Air Survey Co.,Ltd.	Executive	*DEVELOPING AND AAPLYING THE SYSTEM TO SET AREAS AUTOMATICALLY, WHERE NEED TO TAKE WARNING AGAINST SEDIMENT-RELATED DIZASTERS*, 2004 Interpraevent in Italy	*BASIC CONCEPT FOR DEBRIS CONTROL WORK IN MT.KELUD,EAST JAVA, INDONESIA*, South-East Asian Regional Symposium Bangkok,Thailand
43	Nobutomo Osanai	National Institute for Land and Infrastructure Management (NILIM)	Team Leader	(Only in Japanese)	
44	Hiroshi Ikeya	Sabo Technical Center	Chief Executive	Hiroshi.Ikeya,Munehiro.Matsui,Kozo.Mikami:Mt.Unzen-Fugendake Volcano Eruption Implementation of Counter measures, Proc.of the International Sabo Symposium.pp.279-284,1995	Y.Yasuda,Y.Tomomatsu,H.Ikeya,J.Kanbara and T.Ueda: Effects of Hillside Sand Control Works on Restricting Soil Production and Outflow,and Restoration of Greenery by the Works. Inter praevent 2002 in the Pacific Rim-Matsumoto-Japan,Congress publication,vol.2,2002
45	Takashi Yamada	Graduate School of Agriculture, Hokkaido University	Associate Professor	(Only in Japanese)	
46	Masayuki Watanabe	International Institute for Social Development and Cooperation	Chief	(Only in Japanese)	
47	Hiroyuki Yoshimatsu	Institute of Slope Technology	Chief	(Only in Japanese)	

48	Mio Kasai	Erosion and Sedimant Control Research Grope, Public Works Research Institute	Researcher	M.Kasai., K.Fujisawa., T.Kuda., S.Okuda., T.Asahina., M.Matsuda, *Comparison of Morphometry of Active Landslides in Differing Geological Settings Using LiDAR-derived DEMs,* American Geographic Union Fall meeting 2008	M.Kasai, K.Fujisawa, M.Ikeda, *T.Asahina, M.Matsuda, Morphometric Analysis of Landslide-prone Areas in Japan Using LiDAR-derived DEMs* , The First World Landslide Forum 2008
49	Ryosuke Tsunaki	Sabo Technical Center	Manager	(Only in Japanese)	
50	Kazunori Fujisawa	Erosion and Sedimant Control Research Grope, Public Works Research Institute	Team Leader	K.Fujisawa.., J.Ohara (2008): *Simultaneous monitoring of a collapsing landslide by video cameras* , Advances in Geosciences,vol.14	H.Tanaka., K.Fujisawa., K.Asai. (2008): *Identifying unstable rock blocks by measuring micro-tremors and vibration on slopes* , Advances in Geosciences,vol.14
51	Kouji Ishida	Erosion and Sedimant Control Research Grope, Public Works Research Institute	Senior Researcher	(Only in Japanese)	

参考資料 3-6　コース全体の講義・演習スケジュール

Tentative Course Schedule of 2008-2009 Disaster Management Policy Program (Water-related Risk Management Course)

Lecture（Lecturer）

- (1) Basic Hydrology （Prof. Amithirigala Widhanelage JAYAWARDENA）
- (2) Hydraulics （Prof. Tadaharu Ishikawa）
- (3) Introduction to International Cooperation （Mr. Mikio Ishiwatari）
- (4) Basic Concepts of Integrated Flood Risk management (IFRM) （Prof. Kuniyoshi Takeuchi）
- (5) Local Disaster Management and Hazard Mapping （Prof. Shigenobu Tanaka）
- (6) Advanced Hydrology （Prof. Amithirigala Widhanelage JAYAWARDENA）
- (7) Flood Hydraulics and Sediment Transport （Prof. Shoji Fukuoka）
- (8) Sustainable Reservoir Development & Management （Prof. Norihisa Matsumoto）
- (9) Control Measures for Landslide & Debris Flow （Prof. Shun Okubo）
- (10) Disaster Mitigation Policy （Prof. Shigeru Morichi)
- (11) Disaster Risk Management （Prof. Kenji Okazaki)

Excercise（Lecturer）

- (1)P Computer Programming （Prof. Shigenobu Tanaka）
- (2)P Practice on Hydraulics （Prof. Tadaharu Ishikawa）
- (3)P Practice on Inundation Analysis （Prof. Shigenobu Tanaka）
- (4)P Practice on Hazard Mapping （Prof. Shigenobu Tanaka）
- (5)P Practice on Advanced Hydrology （Prof. Amithirigala Widhanelage JAYAWARDENA）
- (6)P Practice on River Training （Prof. Shoji Fukuoka）
- (7)P Practice on Sustainable Reservoir Development & Management （Prof. Norihisa Matsumoto）
- (8)P Practice on Control Measures for Landslide & Debris Flow （Prof. Shun Okubo）

		Sun	Mon	Tue	Wed	Thu	Fri	Sat
		28	29	30	10/1	2	3	4
October	1st class 9:00-10:30						9:30-14:00 Entrance Ceremony at GRIPS	
	2nd class 10:45-12:15		9:45-18:00	10:00-17:00	10:00-17:15			
	3rd class 13:15-14:45		Orientation at JICA TSUKUBA	Orientation at JICA TSUKUBA	Orientation at JICA TSUKUBA			
	4th class 15:00-16:30						16:15-18:00 Entrance Ceremony at ICHARM	
		5	6	7	8	9	10	11
	1st class 9:00-10:30		Orientation Prof. Takeuchi & Prof. Tanaka	Field Trip in Kanto Region	(1)P-1 Programming Language (1) Dr. Hai & Dr. Rajapakse	(1)-2 Precipitation Prof. Jaya	(7)-1 Outline, planning and administration of rivers Prof. Fukuoka	(3) PCM(1)
	2nd class 10:45-12:15				(1)P-2 Programming Language (2) Dr. Hai & Dr. Rajapakse	(1)-3 Extreme weather, Evaporation and evapo-transpiration; Infiltration	(7)-2 Steady quasi-two dimensional analysis of Flood flow (1)	
	3rd class 13:15-14:45		(4)-1 Outline of integrated flood risk management (1) Prof. Takeuchi		(1)P-3 Programming Language (3) Dr. Hai & Dr. Rajapakse		(4)-2 Outline of integrated flood risk management (2) Prof. Takeuchi	
	4th class 15:00-16:30		(1)-1 Basic concepts of the Hydrological Cycle Prof. Jaya					
		12	13	14	15	16	17	18
	1st class 9:00-10:30	(3) PCM(2)		(7)-3 Steady quasi-two dimensional analysis of Flood flow (2) Prof. Fukuoka	(1)P-4 Programming Language (4) Dr. Hai & Dr. Rajapakse	(1)-4 Runoff – Components, measurement and estimation of runoff Prof. Jaya	(7)-5 Unsteady quasi-two-dimensional analysis of flood flows(2) Prof. Fukuoka	
	2nd class 10:45-12:15			(7)-4 Unsteady quasi-two-dimensional analysis of flood flows(1)	(1)P-5 Programming Language (5) Dr. Hai & Dr. Rajapakse	(1)-5 Peak discharge estimation	(7)-6 Prediction method of flow resistance in rivers with compound channels and	
	3rd class 13:15-14:45			(4)-3 Japanese experiences (1) Prof. Takeuchi	(1)P-6 Numerical Computation (1) Dr. Hai & Dr. Rajapakse		(1)P-7 Numerical Computation (2) Dr. Hai & Dr. Rajapakse	
	4th class 15:00-16:30						(1)P-8 Numerical Computation (3) Dr. Hai & Dr. Rajapakse	
		19	20	21	22	23	24	25
	1st class 9:00-10:30		(1)-6 Concept of rainfall excess; Role of infiltration and evaporation Prof. Jaya	Field Trip in Kanto Region (tentative)	(1)-8 Unit Hydrograph Methods II Prof. Jaya	(4)-5 Global trends (1) Prof. Oki	(1)P-9 Numerical Computation (4) Dr. Hai & Dr. Rajapakse	
	2nd class 10:45-12:15		(1)-7 Unit Hydrograph Methods I		(1)-12 Probability and statistics in hydrology I; IDF curves	(4)-6 Global trends (2)	(1)P-10 Numerical Computation (5) Dr. Hai & Dr. Rajapakse	
	3rd class 13:15-14:45		(4)-4 Japanese experiences (2) Prof. Takeuchi		(4)-7 Basic concepts of IFRM (1) Prof. Takeuchi	**13:30-14:30 Homeroom**	**Presentation of Inception Report**	
	4th class 15:00-16:30						**(15minutes for each participants)**	

November

	26	27	28	29	30	31	11/1
1st class 9:00-10:30		Resistration for foreigner	9:00-9:30 Orientation 9:45-10:20 Opening Ceremony	(7)-7 Prediction method of flow resistance in rivers with compound channels and Prof. Fukuoka	(4)P-1 Town Watching (1) Orientation for 1st Town Watching ICHARM staff	(7)-9 Predicting flood flow and bed variation from changes in the Prof. Fukuoka	
2nd class 10:45-12:15			(5)-1 Outline of flood hazard map Prof. Tanaka	(7)-8 Predicting flood flow and bed variation from changes in the Prof. Fukuoka	move to Kurihashi	(4)P-3 Town Watching (3) Group Discussion of 1st Town Watching ICHARM staff	
3rd class 13:15-14:45		Medical Checkup by JICA	(5)-2 Geomorphology around Rivers and alluvial plain(1) Prof. Umitsu	(5)-4 Legislation and Institution concerning to FHM Prof. Tanaka	(4)P-2 Town Watching (2) 1st Town Watching in Kurihashi Town ICHARM staff	(5)P-1 GIS(1) Dr. Magome	
4th class 15:00-16:30			(5)-3 Geomorphology around Rivers and alluvial plain(2)	(5)-5 Disaster management in administration and organization Prof. Tanaka		(5)P-2 GIS(2) Dr. Magoma	
			16:30- Opening Celemony				
	2	3	4	5	6	7	8
1st class 9:00-10:30			(Presentation of Country Report by FHM Course Participants)	(5)-9 Inundation analysis(1) Dr. Osti	(5)-10 Inundation analysis(2) Dr. Osti	(5)-6 Local Disaster Management Plan and Evacuation Planning Prof. Tanaka	
2nd class 10:45-12:15				(5)P-8 Inundation analysis (1) Dr. Osti	(5)-11 Inundation analysis(3) Dr. Osti	(5)P-12 Inundation analysis (5) Dr. Osti	
3rd class 13:15-14:45			(5)P-3 GIS(3) Dr. Magome	(5)P-9 Inundation analysis (2) Dr. Osti	(5)P-10 Inundation analysis (3) Dr. Osti	(5)P-13 Inundation analysis (6) Dr. Osti	
4th class 15:00-16:30			(5)P-4 GIS(4) Dr. Magome	(2)-6 Tour of ICHARM laboratory	(5)P-11 Inundation analysis (4) Dr. Osti	Orientation of Field Trip	
	9	10	11	12	13	14	15
1st class 9:00-10:30		(5)P-5 GIS(5) Dr. Magome	move to Ise City	Field Survey in Ise city	(4)P-5 Town Watching (5) ICHARM staff	Outline of Biwa Lake	
2nd class 10:45-12:15		(5)-8 FHM around the world Prof. Meulen			(4)P-6 Town Watching (6) ICHARM staff		
3rd class 13:15-14:45		(4)-10 Disaster Education Mr. Yoshii	Field Survey in Toyo River, Kiso River	(4)P-4 Town Watching (4) ICHARM staff	(4)P-7 Town Watching (7) ICHARM staff		
4th class 15:00-16:30				(5)-12 Emergency operation and rehabilitation Mr. Kamei	move to Otsu City	move back to Tsukuba City	
	16	17	18	19	20	21	22
1st class 9:00-10:30		9:00-13:45 group work, discussion	(9)-4 Hazard mapping for sediment-related disasters Dr. Takanashi	(1)-9 Remote sensing in Hydrology Mr. Fukami	(4)P-8 Evacuation Planning (1) ICHARM staff	(4)P-10 Preparing Teaching Material (1) ICHARM staff	
2nd class 10:45-12:15			(5)P-14 Inundation analysis (7) Dr. Osti	(5)-7 Human behavior and social psychology Prof. Hayashi	(4)P-9 Evacuation Planning (2) ICHARM staff	(4)P-11 Preparing Teaching Material (2) ICHARM staff	
3rd class 13:15-14:45			(5)P-6 GIS(6) Dr. Magome	(4)-8 Basic concepts of IFRM (2) Prof. Takeuchi	(1)-10 Satellite observation of rainfall (1) JAXA	(4)P-12 Preparing Teaching Material (3) ICHARM staff	
4th class 15:00-16:30		14:00-16:30 presentation	(5)P-7 GIS(7) Dr. Magome	(5)P-15 Inundation analysis (8) Dr. Osti	(1)-11 Satellite observation of rainfall (2) JAXA	(4)P-13 Preparing Teaching Material (4) ICHARM staff	
	23	24	25	26	27	28	29
1st class 9:00-10:30			(4)P-14 Preparing Teaching Material (5) ICHARM staff	(5)-13 Discussion on how to make FHM Prof. Tanaka	(Presentation of Proposal Report by FHM Course Participants)		
2nd class 10:45-12:15			(4)P-15 Preparing Teaching Material (6) ICHARM staff	(5)-14 Discussion on how to use FHM Prof. Tanaka		(5)-15 Examination	
3rd class 13:15-14:45			visit to Ninomiya Sontoku Museum Prof. Tanaka	(for preparation of report)		Closing Celemony and Party at JICA	
4th class 15:00-16:30						**Homeroom**	

	30	12/1	2	3	4	5	6
1st class 9:00-10:30		(1)-13 Probability and statistics in hydrology II; Extreme value distribution Prof. Jaya	(6)P-1 Practice on River Planning (1) ICHARM staff	(6)-1 Hydrological modelling – basic concepts and approaches Prof. Jaya	(6)P-3 Practice on River Planning (3) ICHARM staff	(6)-3 Systems theory approach II – Non-linear systems, multi-linear systems Prof. Jaya	
2nd class 10:45-12:15		(1)-14 Basic concepts of Stochastic Hydrology	(6)P-2 Practice on River Planning (2) ICHARM staff	(6)-2 Systems theory approach I – Linear theory; Time domain analysis;	(6)P-4 Practice on River Planning (4) ICHARM staff	(6)-4 Instantaneous Unit Hydrograph (IUH)	
3rd class 13:15-14:45		(1)P-11 Numerical Computation (6) Dr. Hai & Dr. Rajapakse		(1)P-12 Numerical Computation (7) Dr. Hai & Dr. Rajapakse	(6)P-5 Practice on River Planning (5) ICHARM staff	(1)P-13 Numerical Computation (8) ICHARM staff	
4th class 15:00-16:30							
	7	8	9	10	11	12	13
1st class 9:00-10:30		Instruction of Exercises of Advanced Hydrology	(6)P-6 River Training (1) ICHARM staff	(4)-12 Effects of forests Ass.Prof. Onda	(extra day)		
2nd class 10:45-12:15		Interview for each students	(6)P-7 River Training (2) ICHARM staff	(4)-13 Project assessment (1) Dr. Wakigawa		(1)P-14 Numerical Computation (9) Dr. Hai & Dr. Rajapakse	
3rd class 13:15-14:45		(4)-11 Flood insurance Dr. Watabe	(5)P-1 Exercises on System function estimation ICHARM staff	(4)-14 Project assessment (2)		(1)P-15 Numerical Computation (10) Dr. Hai & Dr. Rajapakse	
4th class 15:00-16:30		Interview for each students	(5)P-2 Exercises on least squares estimation ICHARM staff				

Dece		14	15	16	17	18	19	20
	1st class 9:00-10:30		(6)-5 Conceptual models of IUH	(3) Project Cycle Management	(3) Project Cycle Management	(1)-15 Examination	(6)-7 Rainfall-runoff modelling I – Conceptual type Prof. Jaya	
	2nd class 10:45-12:15		(6)-6 Synthetic Unit Hydrograph			(5)P-3 Exercises on Impulse and Frequency Response Functions ICHARM staff	(6)-8 Rainfall-runoff modelling II – Physics-based type	
	3rd class 13:15-14:45		(4)-9 Early warning Mr. Fukami			(5)P-4 Exercises on IUH determination ICHARM staff	(5)P-5 Exercises on IUH application ICHARM staff	
	4th class 15:00-16:30					Interview		
		21	22	23	24	25	26	27
	1st class 9:00-10:30		(7)-10 1-D Bed Deformation Computing Model Dr. Watanabe		Interview	(extra day)	(extra day)	
	2nd class 10:45-12:15		(7)-11 2-D Bed Deformation Sand Waves and Bars, Meandering		13:30-14:30 Homeroom			
	3rd class 13:15-14:45		(2)P-1 Dr. Yorozuya		(2)P-2 Dr. Yorozuya			
	4th class 15:00-16:30		Interview					
		28	29	30	31	1/1	2	3
	1st class 9:00-10:30							
	2nd class 10:45-12:15							
	3rd class 13:15-14:45							
	4th class 15:00-16:30							
		4	5	6	7	8	9	10
	1st class 9:00-10:30		(extra day)	(extra day)	(6)P-8 River Training (3) ICHARM staff		(extra day)	
	2nd class 10:45-12:15				(4)-15 Examination	(2)-1 Framework of fundamental equation Prof. Ishikawa at JICA Yokohama		
	3rd class 13:15-14:45				(2)P-3 Dr. Yorozuya	(2)-2 Equation for 1-dimention flow		
	4th class 15:00-16:30				(2)P-4	(2)-3 Roughness of channel and normal depth		
		11	12	13	14	15	16	17
	1st class 9:00-10:30							
	2nd class 10:45-12:15			(7)-12 Vegetation Flow in Vegetated Zone Dr. Watanabe	(2)-5 Quiz	(extra day)	(5)P-6 Exercises on a typical rainfall-runoff model I ICHARM staff	
	3rd class 13:15-14:45			(7)-13 River restoration based on sediment transport and vegetation on stabilized	(2)P-5 Dr. Yorozuya		(2)P-6 Dr. Yorozuya	
	4th class 15:00-16:30							
January		18	19	20	21	22	23	24
	1st class 9:00-10:30			(6)P-9 River Training (4) ICHARM staff	9:00-12:00 Interview on Master Thesis	(6)-12 Frequency analysis Prof. Jaya	9:00-10:30 Interview on Master Thesis	
	2nd class 10:45-12:15			(6)-9 Rainfall-runoff modelling III – Data driven type		(6)-14 Errors in frequency analysis Prof. Jaya	(2)P-8 Dr. Yorozuya	
	3rd class 13:15-14:45		(2)P-7 Dr. Yorozuya	(6)-10 Flood routing – Muskingam method; Muskingam-Cunge method Prof. Jaya		(5)P-7 Exercises on a typical rainfall-runoff model II ICHARM staff	13:00-13:30 Explanation on Report of Management, Control Measures for Landslide & Debris Flow Dr. Tarada, Dr. Yamakoshi	
	4th class 15:00-16:30					(5)P-8 Exercises on flood routing ICHARM staff	13:30-15:30 Special Lecture by Dr.Shinji Egashira Title:"Importance of introducing sediment transport process in river planning"	
		25	26	27	28	29	30	31
	1st class 9:00-10:30		(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	
	2nd class 10:45-12:15		(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	
	3rd class 13:15-14:45		(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	
	4th class 15:00-16:30		(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	
		2/1	2	3	4	5	6	7
	1st class 9:00-10:30		(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(6)-10 Flood routing – Muskingam method; Muskingam-Cunge method Prof. Jaya	
	2nd class 10:45-12:15		(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS	(10) Disaster Mitigation Policy at GRIPS		
	3rd class 13:15-14:45		(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS	13:30-17:00 Special Lecture at Cabinet Office	(11) Disaster Risk Management at GRIPS		
	4th class 15:00-16:30		(11) Disaster Risk Management at GRIPS	(11) Disaster Risk Management at GRIPS		(11) Disaster Risk Management at GRIPS		

February

	8	9	10	11	12	13	14
1st class 9:00-10:30		(6)-10 (Cont.) Flood routing – Muskingam method; Muskingam-Cunge method — Prof. Jaya	(8)-1 Outline of Dam Engineering — Dr. Sakamoto		(8)-2 Flood Control Plan — Dr. Umino		
2nd class 10:45-12:15			(9)-1 Outline of sediment-related disasters — Prof. Okubo		(8)-3 Flood Control Operation	(6)-13 Parameter estimation — ICHARM staff	
3rd class 13:15-14:45		13:30-14:00 Explanation on Report of Sustainable Reservoir Development — Dr. Yamaguchi	(9)-2 Introduction to sabo projects		(7)-14 Re-meandering project for river restoration — Dr. Watanabe	(8)-4 Seismic Design for Dams — Prof. Kawasaki	
4th class 15:00-16:30		14:30-16:00 Special Lecture on Koshi River Flood in Nepal			(7)-15 Bank erosion and drift woods		
	15	**16**	**17**	**18**	**19**	**20**	**21**
1st class 9:00-10:30		(Extra Day)	(9)-5 Comprehensive sediment-related disaster measures — Prof. Okubo	(8)-7 Environmental Impact of Dams (1) — Dr. Amano		(9)P-10	
2nd class 10:45-12:15			(9)-3 Countermeasures for sediment-related disasters — Prof. Ishikawa	(9)-6 Countermeasures for earthquake-induced natural dams — Dr. Osanai	(8)-12 Dam Construction (2) — Mr. Takasu	(9)P-11 Training of Development of Procedures for Sediment Disaster Warning and Evacuation — Dr. Takanashi	
3rd class 13:15-14:45			(8)-5 Latest Technology for Concrete Dam (1) — Prof. Kawasaki	(9)-7 Sabo works in arid area and reforestation of degraded lands — Dr. Ikeya		(9)P-12	
4th class 15:00-16:30			(8)-6 Latest Technology for Concrete Dam (2)			(9)P-13	
	22	**23**	**24**	**25**	**26**	**27**	**28**
1st class 9:00-10:30		(5)P-10 Exercises on Kalman filtering II — ICHARM staff	(9)-8 Volcanic sabo works — Ass.Prof. Yamada		(9)-11 Characteristics and topography of landslides — Mr. Kasai	(8)-14 Effective Use of Existing Dams — Prof. Matsumoto	
2nd class 10:45-12:15		(8)-11 Dam Construction (1) — Dr. Yamaguchi	(9)-9 Application of sabo works and landslide countermeasures to — Mr. Watanabe		(9)-13 Survey and emergency response for landslide — Dr. Fujusawa	(8)-15 Roles of Dams in 21st Century	
3rd class 13:15-14:45		(8)-13 Dam Management — Dr. Yamaguchi	(9)-10 Introduction of landslides — Mr. Yoshimatsu		(5)P-11 Exercises on Frequency analysis I — Prof. Jaya	(6)-11 Kalman Filtering — Prof. Jaya	
4th class 15:00-16:30						(5)P-9 Exercises on Kalman filtering I — Prof. Jaya	

March

	1	2	3	4	5	6	7
1st class 9:00-10:30		(9)-12 Stability analysis for landslide — Dr. Tsunaki	(5)P-12 Exercises on Frequency analysis II — Prof. Jaya	(8)P-12 Practice on Dam Design (3) — Mr. Sakurai		(Technical Support by Prof Egashira)	
2nd class 10:45-12:15		(9)-14 Maintenance measures for roads and reservoirs in landslide areas — Dr. Fujusawa	(8)-8 Environmental Impact of Dams (2)	(8)P-13 Practice on Dam Design (4)			
3rd class 13:15-14:45			(8)-9 Sediment Management in Reservoirs (1) — Ass.Prof. Sumi	(9)-15 Permanent measures for landslide damage reduction — Mr. Ishida		(9)P-14 Application of sabo/landslide projects for other countries — Dr. Ikeya&Dr. Nishimoto&Dr. Terada	
4th class 15:00-16:30			(8)-10 Sediment Management in Reservoirs (2)		(7) Mechanics of bed load, suspended load and debris flow — Prof.Egashira	(9)P-15	
	8	**9**	**10**	**11**	**12**	**13**	**14**
1st class 9:00-10:30		Field Trip to Chugoku Region				**9:30-15:30**	
2nd class 10:45-12:15						(2)-4 Critical depth, Subcritical flow, Supercritical flow — Prof. Ishikawa at JICA Yokohama	
3rd class 13:15-14:45						(2)-7 Over flow and jump flow	
4th class 15:00-16:30						(2)-8 Gradually varied flow (1)	
	15	**16**	**17**	**18**	**19**	**20**	**21**
1st class 9:00-10:30			(8)P-14 Application of dam projects for other countries — Prof. Matsumoto & Dr. Yamaguchi		(7) Examination		
2nd class 10:45-12:15		(5)P-13 Exercises on Frequency analysis III — ICHARM staff	(8)P-15				
3rd class 13:15-14:45							
4th class 15:00-16:30							
	22	**23**	**24**	**25**	**26**	**27**	**28**
1st class 9:00-10:30		(6)-15 Examination	(Technical Support by Prof Egashira)				
2nd class 10:45-12:15						**Homeroom**	
3rd class 13:15-14:45		(2)P — Dr. Yorozuya		(2)P — Dr. Yorozuya		(2)P — Dr. Yorozuya	
4th class 15:00-16:30		(7) Evaluation of river changes — Prof.Egashira					

April

	29	30	31	1	2	3	4
1st class 9:00-10:30			**Homeroom**				
2nd class 10:45-12:15			(2)-9 Gradually varied flow (2)		(2)P Dr. Yorozuya		
3rd class 13:15-14:45			(2)-10 Unsteady flow — Prof. Ishikawa at ICHARM				
4th class 15:00-16:30			(2)-11 Multi-crossed channel		**15:00-15:30 19th ICHARM R&D Seminar**	**15:00- Tea Ceremony and Cherry Blossom Viewing**	
	5	**6**	**7**	**8**	**9**	**10**	**11**
1st class 9:00-10:30						(7) Evaluation of river changes Prof.Egashira	
2nd class 10:45-12:15		(2)P Dr. Yorozuya		(2)P Dr. Yorozuya			
3rd class 13:15-14:45			**13:30-15:00 20th ICHARM R&D Seminar**				
4th class 15:00-16:30							
	12	**13**	**14**	**15**	**16**	**17**	**18**
1st class 9:00-10:30							
2nd class 10:45-12:15				(2)-12 Junction flow and diversion flow — Prof. Ishikawa at Tokyo Institute of Technology			
3rd class 13:15-14:45				(2)-13 Retarding basin			
4th class 15:00-16:30			**15:00-16:00 ICHARM Open Day**	(2)-14 Curved area and bar			
	19	**20**	**21**	**22**	**23**	**24**	**25**
1st class 9:00-10:30						(Technical Support by Prof Egashira)	
2nd class 10:45-12:15				(2)-15 Examination			
3rd class 13:15-14:45							
4th class 15:00-16:30							
	26	**27**	**28**	**29**	**30**	**1**	**2**
1st class 9:00-10:30							
2nd class 10:45-12:15		10:30-12:00 Explanation of the result of "Hydraulics" Examination					
3rd class 13:15-14:45		**Exercize on Inundation Analysis Dr. Hai**					
4th class 15:00-16:30							

May

	3	4	5	6	7	8	9
AM							
PM							
	10	**11**	**12**	**13**	**14**	**15**	**16**
AM							
PM							
	17	**18**	**19**	**20**	**21**	**22**	**23**
AM					(Technical Support by Prof Egashira)	(Technical Support by Prof Egashira)	
PM							
	24	**25**	**26**	**27**	**28**	**29**	**30**
AM				Interim presentation of Master thesis			
PM							
	31	**1**	**2**	**3**	**4**	**5**	**6**
AM				Field Trip to Touhoku Region			
PM							

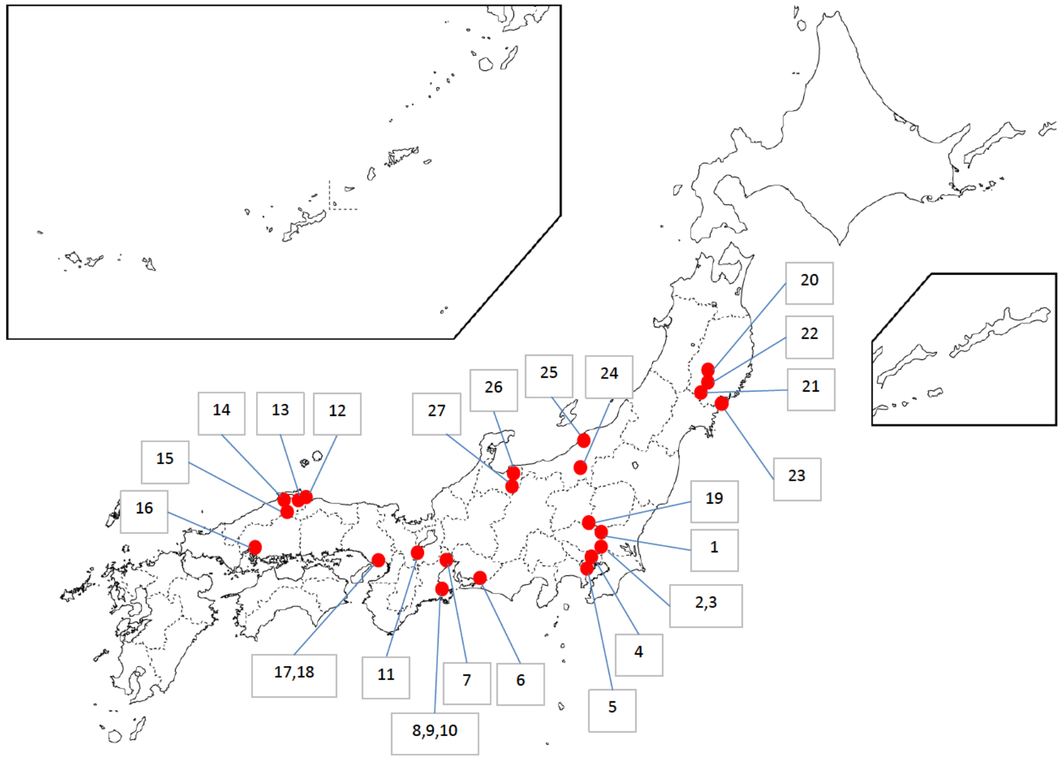
June		7	8	9	10	11	12	13
	AM			(Technical Support by Prof Egashira)				
	PM							
		14	15	16	17	18	19	20
	AM							
	PM							
		21	22	23	24	25	26	27
	AM			(Technical Support by Prof Egashira)				
	PM		(Technical Support by Prof Egashira)					
July		28	29	30	7/1	2	3	4
	AM				Submission of complete draft of Master's Thesis to supervisor			
	PM							
		5	6	7	8	9	10	11
	AM							
	PM							
		12	13	14	15	16	17	18
	AM							
	PM							
		19	20	21	22	23	24	25
	AM							
	PM							
		26	27	28	29	30	31	8/1
	AM							
	PM							
August		2	3	4	5	6	7	8
	AM						Final presentation of Master thesis	
	PM							
		9	10	11	12	13	14	15
	AM							
	PM							
		16	17	18	19	20	21	22
	AM				Japan Society of Hydrology and Water Resources in Kanazawa			
	PM							
		23	24	25	26	27	28	29
	AM						(Submission of Master's Thesis to GRIPS)	
	PM							
September		30	31	9/1	2	3	4	5
	AM				Faculty meeting for judgment			
	PM							
		6	7	8	9	10	11	12
	AM						**11th International Summer Symposium at Tokyo Institute for Technology**	
	PM							
		13	14	15	16	17	18	19
	AM						Evaluation Meeting	
	PM				Graduation Ceremony at GRIPS		Closing Ceremony & Party at JICA	

参考資料 3-7　見学箇所一覧とそれぞれの施設の概要と学習のポイント

2008-2009 防災政策プログラム 水災害リスクマネジメントコースにおける現地見学

視察日		視察箇所	施設の概要・学習のポイント	河川						コミュニティ防災	海岸	湖沼	ダム	砂防	ポイント
				構造物の形状											
				放水路	スーパー堤防	堤防強化	遊水地	（我が国の新技術を活かした、精緻な大規模構造物）	（古くからの智恵）						
10月7日 Field trip (1)	1	渡良瀬遊水地	利根川と渡良瀬川の合流地点に近く、利根川の増水を一旦受け止める施設として機能する遊水地。普段は**周辺住民の憩いの場**ともなっており、利用の実態を見学・学習。				○								住民との共生 総合流域マネジメント
	2	首都圏外郭放水路	標高の低い中川流域で多発していた浸水被害が軽減させるため、河川増水時には国道16号線の地下を経由させて、江戸川へ放出させる放水路。**大規模構造物による洪水対策の一例**として見学・学習。	○				○							大規模構造物による洪水管理
	3	江戸川スーパー堤防	江戸川の堤防強化と同時に河川に面して住宅地の造成が行われた現地を見学し、**堤防強化による洪水対策の一例**として見学・学習。		○										堤防強化による洪水対策
10月21日 Field trip (2)	4	神田川・環状7号線 地下調節池	東京西郊の神田川流域の洪水被害軽減のために環状7号線地下に建設された、直径12.5m、全長4.5kmのトンネル地下調整池を見学し、**土地に制約のある都市内における洪水対策の一例**として見学・学習。	○				○							大規模構造物による洪水管理
	5	鶴見川遊水地	ここ数十年で流域の都市化が急速に進行して、地中への浸透量が減少し、豪雨時の洪水被害が増加した鶴見川流域の遊水地。通常日産スタジアムとしても使用されている例を概観し、**総合治水**のあり方を学習。				○	○							総合治水 総合流域マネジメント
11月11日-14日 Field trip (3)	6	豊川	洪水時には、**不連続堤（霞堤）**から増水が農地などに流入して河川水の上昇を防ぐ古くからの堤防施設を見学し、必ずしも大規模な構造物によらずとも洪水対策も可能な一例として学習。						○ （霞堤）						大規模構造物によらない洪水管理
	7	三川（木曽川・揖斐川・長良川）分離事業・輪中	江戸時代に三つの川を**仕切り堤で分離**して流域の洪水被害軽減に貢献した事例を、現地の見学タワーから俯瞰し学習。また、現地に復元されている**輪中施設**を見学し、**洪水時の住民の智恵**を学習。						○						大規模河道改修
	8	宮川	2004年に洪水浸水被害を受けた地区における堤防改修事業を見学し、**堤防による河川強化法**を学習。			○									堤防強化による洪水対策
	9	伊勢市円座地区	「共助」の基本である**コミュニティ防災**の重要性を、現地のコミュニティリーダーからヒアリングし、平常時のつきあいが緊急時に力を発揮することを学習。							○					コミュニティ防災
	10	伊勢市大湊地区	「共助」の基本である**コミュニティ防災**の重要性を、現地のコミュニティリーダーからヒアリングし、地区単位での安全マップの作成や全員参加の避難訓練など、様々な防災活動が行われていることを学習。							○					コミュニティ防災
	11	琵琶湖	「近畿のみずがめ」としての**水資源管理**、下流への洪水対策、湖沼の水質環境などを現地の資料館を訪問し、学習。									○			水資源管理
3月9日-12日 Field trip (4)	12	皆生海岸	海岸浸食を防ぐための、**総合流砂対策事業**を見学し、学習。								○				総合流砂対策
	13	和鋼博物館	中国山地でのたたら鉄生産がいかに河川の土砂生産に関係したかを理解し、洪水対策との関連を学習。												河川計画、 土砂輸送
	14	大橋川・斐伊川	ダム建設・放水路建設・河道拡幅の「3点セット」を含んだ**河川整備計画のあり方**を、現地の資料館での展示物なども見ながら実際の放水路建設現場を見学し、学習。	○											河川整備計画
	15	尾原ダム	我が国の代表的な**コンクリート重力式ダム建設現場**を見学し、一連の作業工程や必要性などを学習。										○ （重力式）		
	16	太田川	下流に大都市・広島を抱える太田川での**河川整備計画**を学ぶために、洪水・高潮対策（堰、放水路、高潮堤防など）や環境対策（せせらぎ水路など）を見学し、および堰管理所を訪問。	○											大都市での河川計画
	17	たかとりコミュニティセンター	1995年の阪神・淡路大震災で甚大な被害を被った神戸市長田地区は特に韓国人とベトナム人の比率が高く、コミュニティラジオや料理教室など多様な活動を通じて日本人と外国人の融合を図っていることなど、平常時からのつきあいがいざという際に力を発揮することが紹介された。							○					コミュニティ防災

	18	人と防災未来館	阪神・淡路大震災の被害の状況やその後の復旧・復興の歴史、教訓を学習した。													復旧・復興
5月16日 Field trip (5)	19	第58回利根川水系連合水防演習	佐野市で行われた水防演習に参加し、様々な水防工法と洪水時の情報伝達システムを現地で学習した。						○							水防システム
6月3日-5日 Field trip (6)	20	胆沢ダム	石淵ダムの再開発ダムとして建設されている**ロックフィル式ダム**を見学し、再開発ダムとしての役割や一連の建設工程を見学。											○ (ロックフィル式)		大河川での河川整備計画
	21	一関遊水地	東北の大河川である北上川の**総合治水計画**の一環である遊水地を見学し、用地確保の課題や遺跡対策などについて現地を見学し、学習。				○									
	22	岩手県奥州市羽田地区	北上川に隣接する羽田地区が、平成14年に受けた洪水被害を契機として行ってきた、**様々なコミュニティレベルの防災活動**を住民の方からヒアリングし、学習。							○						コミュニティ防災
	23	宮城県気仙沼市	地震による津波被害を幾度となく経験している気仙沼市の津波対策について講義頂き、**津波と洪水の考え方の違いと共通点を探り**、洪水対策の参考にする。													津波対策
8月18日-21日 Field trip (7)	24	芋川	2004年中越地震の震源地近くにあり、流域で数多くの**地すべりや天然ダム**が発生したため、さまざまな砂防事業が行われた現場を見学し、学習する予定。												○	天然ダム 地すべり対策
	25	信濃川	古くは低湿地であった越後平野の農地拡大および洪水被害軽減のために建設された放水路事業と資料館の展示物を現地で見学し、学習する予定。また、固定堰から**可動堰への改築工事**が始まっており、建設工程も見学可能。	○												可動堰建設
	26	黒部川	日本有数の急流河川であり、ダム同士の**連携排砂**や**霞堤**など様々な総合土砂管理のあり方を現地で見学し、学習する予定。						○ (霞堤)					○ (重力式)		総合土砂管理 連携排砂
	27	黒部ダム	日本最大の**コンクリートアーチダム**であり、下流の洪水対策とともに、我が国戦後の高度復興期を発電施設として支えた当ダムの意義を見地を見学し、学習する予定。											○ (アーチ式)		発電



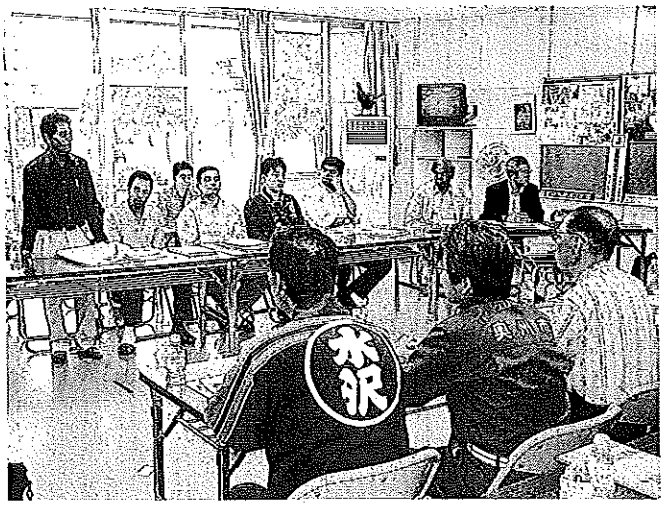
参考資料 4-1　胆江日日新聞記事

（奥州市羽田地区での意見交換の様子）

〝羽田式防災〟関心高く

研究機関の海外留学生 住民と意見交換

水沢



茨城県つくば市の独立行政法人土木研究所「水災害・リスクマネジメント国際センター」の海外留学生たちが3日、水沢区の羽田公民館を訪れ、地元住民らと意見交換した。留学生たちは、カスリン・アイオン台風を教訓にした羽田地区の防災への取り組みについて理解を深めた。

留学生たちが羽田地区の水害対策について理解を深めた意見交換会

留学生は中国やインドネシア、エチオピアやネパールなど6カ国から来た26―40歳の8人。同センターに1年間留学し、日本の防災技術やノウハウを学んでいる。以前から羽田地区の防災活動に注目していた国土交通省の職員が橋渡し役となり、意見交換会が実現した。

意見交換会には、留学生や岩手河川国道事務所の職員のほか、羽田地区振興会や地元消防団員ら計24人が参加した。

同公民館の佐藤義正館長が、02（平成14）年7月の台風6号による羽田地区の被害状況を説明。伊手川堤防を越えた洪水が、東北新幹線水沢江刺駅付近の田んぼを覆い尽くした写真などをスライドで映すと、留学生たちは食い入るように見入っていた。洪水ハザードマップの作製やカスリン・アイオン台風体験集発行、自主防災避難訓練への取り組みなども紹介した。

同振興会の元理事、高橋俊一さん（75）がカスリン台風の体験談を披露。「本当に悲惨な状況だった。物資もなく、死者も出たし、多くの家屋が流出した」などと語ると、留学生たちは皆真剣な表情。

「災害発生時の情報の伝え方に地域独自の手法はあるか」「台風のように急に水位が上がった場合、1次避難場から出られなくなってしまうのでは」「カスリン台風の時に最も困ったことは？」などとメモを取りながら、熱心に質問していた。

管内関連記事	平成21年 6月 5日
朝日・河北・岩手日日・胆江日日・岩手日報（朝・夕）6面	

参考資料 5-1　修士論文梗概集

WATER LEVEL PREDICTION BY ARTIFICIAL NEURAL NETWORK IN THE SURMA-KUSHIYARA RIVER SYSTEM OF BANGLADESH

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MEE08177

ABSTRACT

The nonlinear relationship between rainfall and water levels is one of the most complex hydrologic phenomena to figure out due to the involvement of spatial and temporal inconsistent geomorphic and climatic factors. In this study, attempt is made to recognize the water levels pattern in the Surma-Kushiyara River system of Bangladesh by artificial neural network. Only recorded past rainfall and water levels information are utilized. Multilayer perceptron (MLP) and radial basis function network (RBFN) are the two feed forward neural networks which are applied for this envisagement. In MLP, logistic sigmoid activation function with unit steepness parameter is exercised for non-linear transformations in both hidden and output layers. Synaptic weights are adjusted using modified delta rule through error back propagation algorithm. Batch mode of training is adopted for global error minimization. The back propagation algorithm is considered to have converged when the absolute rate of change in averaged square error per epoch approaches to zero. The basis function for the RBFN is Gaussian in form. Numbers of centers which determine the dimension of space nonlinearity in the hidden layer are chosen by k-means clustering. The transformations from input to hidden layer and hidden to output layer are nonlinear and linear respectively. Finally, statistical indicators are used to evaluate the prediction performance of neural network. It is observed that both MLP and RBFN are capable to identify the intricate pattern of water levels in the Surma River. One, two and three day lagged rainfall in conjunction with one day lagged water levels is capable to recognize the water level patterns. With the increase of lead time, the performances of statistical indicators became inferior slightly. Higher water levels are predicted more fairly than the lower water levels. In the case of MLP, single hidden layer with two hidden neurons are found adequate to train the network. Higher numbers of hidden neurons are speeding up the training procedure with unacceptable generalization for application. The learning rate and momentum coefficient equal to 0.10 and 0.50 respectively formulates better results. Higher number of hidden neurons is required for RBFN. In RBFN, the numbers of iterations that are required to produce the acceptable results is lower than multilayer perceptron but better generalization is achieved in multilayer perceptron.

Keywords: multilayer perceptron, error back propagation, modified delta rule, batch mode, radial basis function network.

INTRODUCTION

Prediction of water level in a river system is of great interest for water management and flood control. In Bangladesh, the simulation model 'MIKE11' and a special version of 'MIKE11 FF' conceptual hydrodynamic model are in operation to forecast water levels (FFWC, 2008). It involves runoff calculation, flow routing to the desired downstream location from the upstream observation and conversion of flow to water level by using a rating curve. But difficulties are associated to construct an authenticated rating curve and accurately present spatially distributed heterogeneous geomorphic and climatic factors to the model. The study area is located at the agriculturally and ecologically

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important northeast hydrological region of Bangladesh where flash flood during pre-monsoon (March-May) season is very common and one of the major concerns for the economy. Steep upstream basin topography, short concentration time, sudden excessive rainfall and flashy character of the rivers are the driving components of rapid water level rises and falls with little or no advance warning. The principal river is the Barak which divides into Surma and Kushiyara River at the border of Bangladesh and India. Total catchment areas of Surma and Kushiyara River are approximately 8176 km^2 and 36945 km^2 (BUET, 2008) respectively which are stretched in India and Bangladesh. Surma River is fed by the heavy rainfall of Meghalaya and Assam area. Unfortunately available rainfall information of Indian hilly area is very limited which is a big challenge for water levels prediction in these rivers. Figure 1 shows the Surma and Kushiyara River along with water levels measuring station.

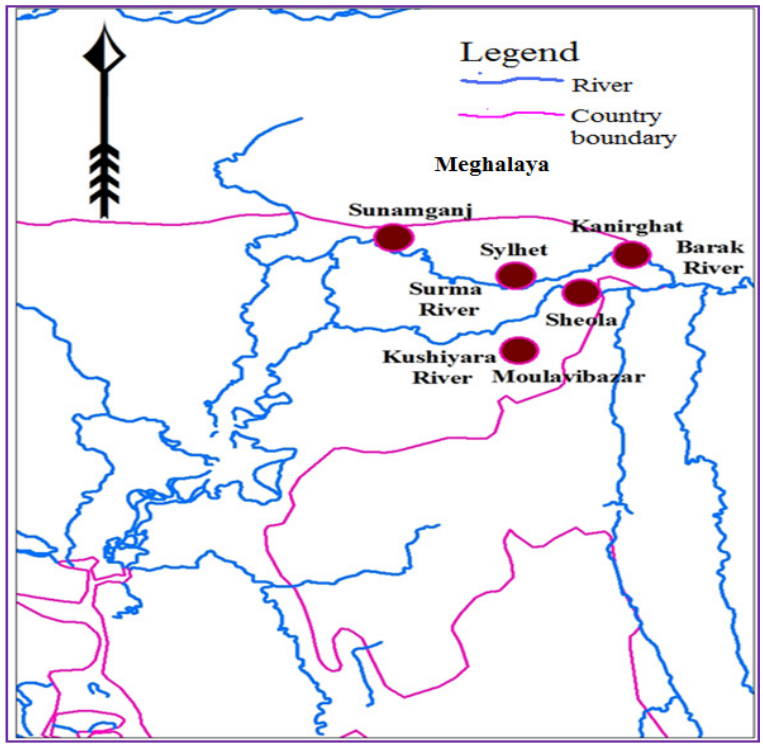


Figure 1: Surma and Kushiyara River with water levels measuring stations

DATA

Daily water levels and rainfall data are collected manually by the Bangladesh Water Development Board (BWDB). Data from 18/8/1980 to 28/8/2008 at Sylhet and Sunamganj gauging stations of river Surma are utilized for training, validating and application by splitting into three equal parts. Table-1 summarizes the data that are used in this study in different phase of simulation.

Table 1: Summary of used data in training, validation and application phases of simulation

Data source	Station	River	Total data range	Training range	Validation range	Application range
BWDB	Sylhet	Surma	18/8/1980 to 28/8/2008	21/8/1980 to 23/12/1989	24/12/1989 to 27/4/1999	28/4/1999 to 28/8/2008
BWDB	Sunamganj	Surma	18/8/1980 to 28/8/2008	21/8/1980 to 23/12/1989	24/12/1989 to 27/4/1999	28/4/1999 to 28/8/2008

THEORY AND METHODOLOGY

The adopted methodology is consisted of correlation analysis, principal component analysis, designing the architecture of MLP and RBFN, finding suitable data normalization range, training the network and generalization for application. Initial combination of rainfall and water levels in an input pattern are selected by autocorrelation, cross-correlation and principal components analyses. Sensitivity analysis is performed to decide an appropriate rainfall and water levels combination in an input pattern, data normalization range, number of hidden neurons in the hidden layer, learning rate

parameter and momentum coefficient. These selected parameters are applied for higher lead-time prediction.

The activities of MLP are composed of forward and backward passes. The forward pass starts with the presentation of the input data to the network. These inputs are the stimulus signal of the network. Before presenting the data to the network, the input and desired output data for training, validation and application are normalized using the relationship as delineated below:

$$\text{Normalized Value}=\text{Lower bound}+\frac{(\text{Value-Minimum})(\text{Upper bound-Lower bound})}{(\text{Maximum-Minimum})}$$

where 'Lower bound' and 'Upper bound' are expected minimum and maximum response of the network, 'Maximum' and 'Minimum' is the highest and lowest value of a data set.

The feed-forward type neural network with sigmoid activation function is adopted in this study because of its simplicity and ability to approximate any continuous function (Flood & Kartam, 1994a). Mathematically, the general form of response function of two-layer perceptron network with single output neuron, I_n number of variables in an input pattern and 'h' number of hidden neurons is expressed in Eq. 1. Figure 2 shows the working principle of MLP.

$$y=f\left(w_0^{(2)}+\sum_{\alpha=1}^{h} w_\alpha^{(2)} f\left(w_{\alpha 0}^{(1)}+\sum_{\beta=1}^{I_n} w_{\alpha\beta}^{(1)} x_\beta\right)\right) \quad (1)$$

where, x_β are the input variables, $f(\cdot)$ is logistic sigmoidal nonlinear activation function, $w_{\alpha\beta}^{(1)}$ and $w_{\alpha 0}^{(1)}$ are input weights and thresholds, $w_\alpha^{(2)}$ and $w_0^{(2)}$ are second layer weight and threshold.

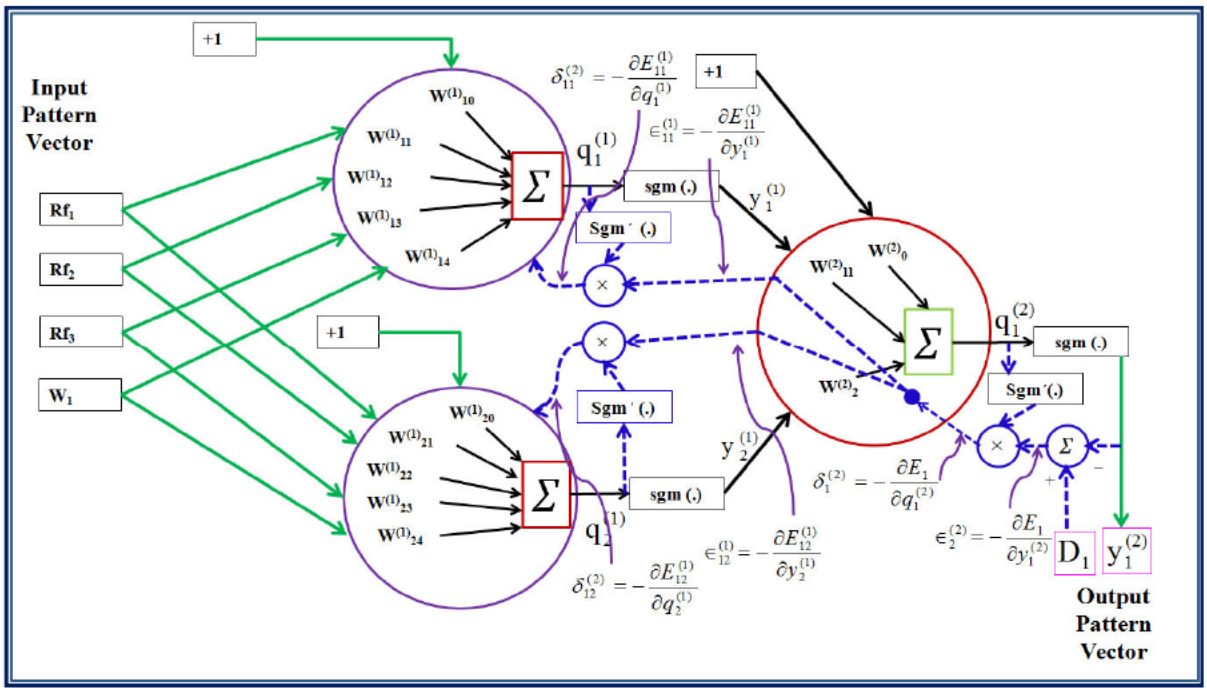


Figure 2: Forward and backward pass details of MLP

Initial weights and biases for both hidden and output layers are chosen randomly. The difference between network output and target output corresponding to the input pattern determines the error. Backward pass starts with the back propagation of the error through the network. The batch mode of training in back propagation learning and weight updating is used because of its capability to accurately estimate the gradient vector (Haykin, 1998). The objective of training is to reconstruct the hyper-surface of input-output mapping by reducing the global error E which is defined by Eq. (2).

$$E=\frac{1}{2N}\sum_{i=1}^{N}(y_i-d_i)^2 \quad (2)$$

where, N=total number of training pattern, y_i=network output for i^{th} input pattern and d_i= corresponding desired output.

Steepest descent or gradient descent algorithm is involved for the minimization of the global error. The network weights and biases, on which the global error depends, are adjusted by moving a small step in the direction of the negative gradient of the error function after an epoch. The iterations are repeated until the absolute rate of change in averaged square error per epoch approaches zero.

The function defined by Poggio and Girosi (1990) is exercised with the intention of reconstructing the solution surface during the application of radial basis function network. The general mathematical form is given as below:

$$F(x)=\sum_{i=1}^{C} w_i G(x,t_i)$$

$G(x,t_i)$ is the basis function which can be expressed as shown in Eq. 3.

$$G(x;t_i)=\exp\left(-\frac{1}{2\sigma^2}\|x-t_i\|^2\right)=\exp\left[-\frac{1}{2\sigma^2}\sum_{i=1}^{C}\|x-t_i\|^2\right] \quad (3)$$

where, C is the number of center, σ is the common variance, w_i is weight from hidden to output layer, t_i is the selected centers of the data set by k-means clustering, x is an input pattern.

RESULTS AND DISCUSSION

Sensitiveness of rainfall water levels combination: A number of rainfall and water level combinations are used for both stations to select the appropriate rainfall and water levels arrangement to predict the water levels with twenty four hours lead-time. Sensitivity analysis indicates that one, two and three day lagged rainfall along with one day lagged water levels is capable to comprehend the water level pattern splendidly. Concordance between measured and predicted water level pattern along with their linear relationship are shown in Figures 3 and 4 as an example in the form of time series and scatter plotting for the application phase of simulation at Sylhet gauging station.

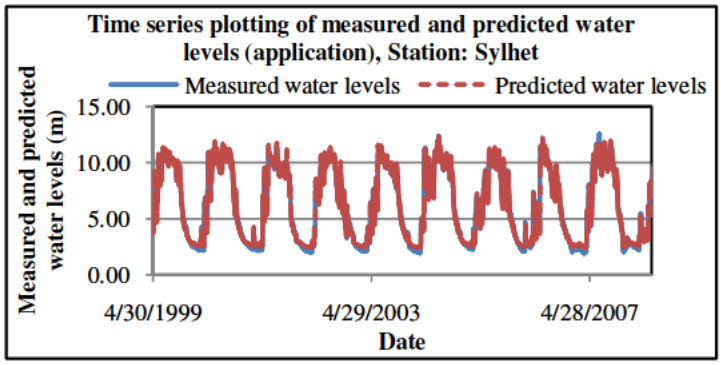


Figure 3: Concordance between measured and predicted water levels

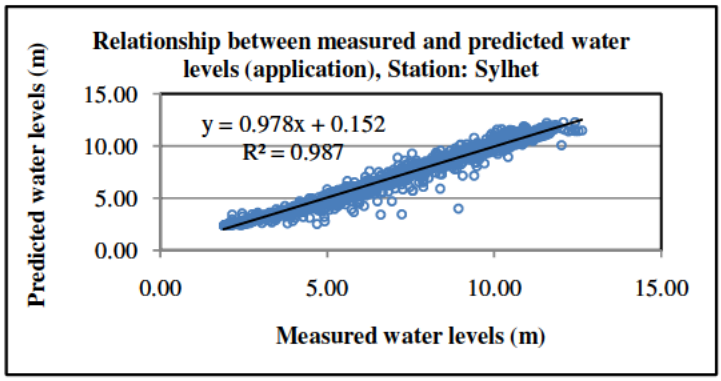


Figure 4: Colinearity of measured and predicted water levels

The value of mean absolute error which measures the closeness of prediction is lowest. The overall spread of predicted water levels with respect to the mean of the observed water levels is also lowest. Nash and Stucliffe's (1970) coefficient of efficiency (EF) measures how well the plot of the observed versus simulated

value fits the 1:1 line. In the training, validation and application phases of simulation, the attained value of EF is 0.99 for both stations which is very close to the optimum value. Scattering of the predicted and observed values is measured by taking the ratio of the variance of the observed water levels to the predicted water levels around the mean of the observed water levels. The optimum value is 1.0. The obtained value of this indicator is 1.03 and 1.02 for application phase of simulation at Sylhet and Sunamganj gauging stations respectively. This represents that the measured and predicted water levels follow same straight line.

Influence of learning rate parameter and momentum coefficient: The changing patterns of relative root mean square error per epoch for different values of learning rate parameter (momentum coefficient=0.50) at Sunamganj gauging station are shown in Figure 5. The analysis indicates that for lower momentum coefficient and learning rate parameter, the required numbers of epochs to attain the convergence point are higher than that of the higher value of these parameters. Larger momentum coefficients are able to improve this slowness. But there exists the potential danger of oscillation in the generating error surface. Learning rate constant and momentum coefficient equal to 0.10 and 0.50 respectively gives best generalization.

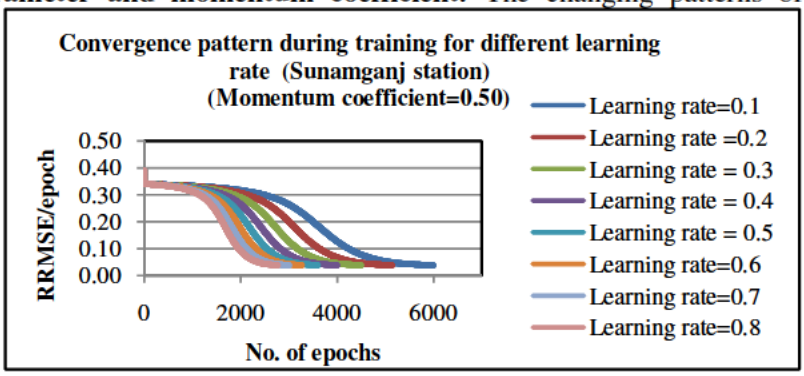


Figure 5: Convergence pattern of RRMSE

Outline of selected parameters of multilayer perceptron: Based on the results of the sensitivity analysis one, two and three day lagged rainfall in conjunction with one day lagged water levels are selected as the variables in an input pattern. The number of hidden layer is one and it is composed of two hidden neurons. The chosen learning rate parameter and momentum coefficient are 0.1 and 0.5 respectively. These values are used in both layers. Using the normalization range (0.20-0.80), synaptic weight of the network is computed.

Application for forecasting with longer lead-time: The parameters which are selected based on sensitivity analysis are applied for prediction of water levels with 48 hours lead-time. Statistical indicators suggested that the performance of prediction is dwindling with the increase of lead-time though these indicators are very close to their optimum value. The value of R^2 is close to 1.0 which signifies a very good linear regression correlation between the measured and predicted values. Mean absolute error is becoming higher in the case of longer lead-time prediction. This indicates that the deviation of predicted values from the measured values is increasing. The agreement between the measured and predicted water levels at Sunamganj gauging station with 48 hours lead-time is shown in Figure 6. The plotting represents good co-linearity between measured and predicted water levels.

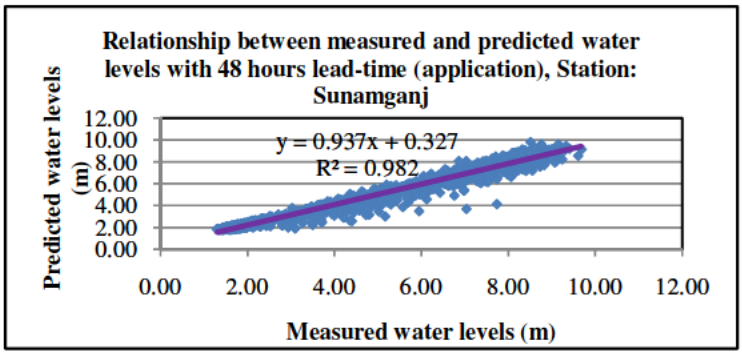


Figure 6: Colinearity between measured and predicted water levels with 48 hours lead-time

Application of RBFN: Application of RBFN indicates that with the increase hidden layer dimension, the performance of the prediction is becoming better for both stations. The colinearity between measured and predicted water levels at Sylhet gauging station in application phases of simulation for

number of centers equal to twenty are illustrated in Figures 7. The value of MAE is getting lower with the increase of dimensionality. R^2 is very close to 1.0 which signifies good linear regression relationship between measured and predicted water levels. The performances of relative root mean square error are almost similar in both methods. The value of Nash and Stucliffe coefficient of efficiency (EF) is 0.98 which indicates that most of the predictions are fitted well with the 1:1 line. This is same for Sunamganj station as well. The scatter of the predicted and observed values around the mean of the observation indicates that the variances of predicted and measured water levels are almost same. So RBFN is capable to recognize the water levels pattern.

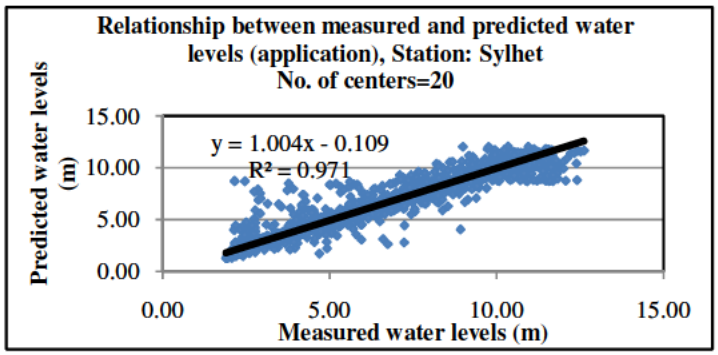


Figure 7: Colinearity of measured and predicted water levels in RBFN

CONCLUSIONS

Both multilayer perceptron and radial basis function networks are capable of predicting the water levels in the Surma river system. Radial basis function network has relatively higher dimensions in hidden layer than that of the multilayer perceptron. Number of iterations required to produce a desirable results in the case of multilayer perceptron with back propagation algorithm is higher than RBFN. One hidden layer consisting of two hidden neurons is adequate to train the network for MLP. Multilayer perceptron is giving better generalization results than radial basis function networks. The performance of forecasting results is receding with longer lead-time.

RECOMMENDATION

Future study should be conducted to reduce of the dimensionality of the radial basis function network by searching optimum number of centers using the statistical properties of the data pattern.

ACKNOWLEDGEMENT

I would like to express my solemn gratitude to my supervisor Prof. Dr. A. W. Jayawardena, Research and Training Advisor, ICHARM, PWRI, Tsukuba, Ibaraki, Japan for his overall supervision, invaluable suggestions and ardent encouragement in every aspect of this work.

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MIGRATION CHARACTERISTICS OF MEANDERING CHANNELS BASED ON RIVER MORPHODYNAMICS

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MEE 08178

ABSTRACT

Present research is aimed to test the possibility of using a mathematical model, based on river mechanics principles, as a tool to assess the migration characteristics of meandering rivers. Sand and silt bed rivers are dominating in Bangladesh. The rivers also carry a huge amount of sediment from the upstream reaches. These factors combined with seasonal change of flow discharge have contributed to the morphological characteristics of the rivers. Shifting of channel, excessive scour of fine bed materials, meander development and migration intensify bank erosion. Some difficulty for evaluating bank erosion hinders the proper planning for river management. Therefore, topics associated with channel shifting and bank erosion have been chosen for present study.

Scouring of curved channels and migration of meandering channels were studied using existing models in order to obtain information for river management. Special attention was paid for applicability of the models to the Madhumati River in Bangladesh. In order to evaluate local scouring resulting from curved flows, bed topography models developed by Engelund (1974) and Ikeda (1974) were reviewed and their validities were investigated. In those models, the secondary flow plays an important role on the relation among the direction of sediment particle migration, direction of fluid force and transverse bed slope and is taken into account through the transverse bed slope parameter. It was found that transverse bed profile can be computed fairly well by the model developed by Ikeda (1974). Maximum scour depth can also be predicted by means of this model supposing the side bank is composed of non-erodible wall.

Prediction of channel shifting using numerical simulations was identified as an important tool to conduct site adaptive countermeasures in river management. The meander migration models proposed by Ikeda et al. (1981) and by Hasegawa (1989) were applied to predict the migration of a meander bend of the Madhumati River and were examined by comparing the simulated results and corresponding field data. Ikeda et al.'s model which was proposed originally to evaluate dominant wave lengths of meandering channels is able to discuss the channel migration based on a linear relation between the excess velocity and bank erosion rate. Hasegawa's model, which is based on the same linear relation as Ikeda et al.'s, includes the erosion rate formula that is derived from integration of sediment continuity equation. It is found that the both model could be acceptable for evaluating the channel shift although some improvements may be necessary. Especially, Hasegawa's model will predict well the bank erosion and corresponding channel shift if the flow width is specified carefully. Nevertheless, such meander migration models provide a valuable and easy-to-use tool to analyze migration characteristics of meandering channels.

Keywords: Meandering channel, Migration characteristics, River morphodynamics.

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INTRODUCTION

Bangladesh is located in a low-lying delta where more than three hundred alluvial channels have made an intricate network of rivers. The total length of the river network including tributaries and distributaries is more than 150,000 km. The floodplains and river reaches consist mainly of recent alluvial deposits. The soil material is fine-grained and the ground is loosely packed or unconsolidated. The rivers also carry huge amount of sediment from the upstream reaches. These factors combined with seasonal change of flow discharge have contributed to the morphological characteristics. Shifting of channel, excessive scour of fine bed materials, meander development and migration frequently intensify bank erosion. Throughout the country about 1200 km of riverbanks are under severe erosion problem (Figure 1). Around eight thousand hectares of lands are eroded every year. The impact of land loss involves primarily the loss of homestead land, housing structures, crops, trees and households. Loss of homesteads force people to move to new places without any option and puts them in disastrous situation. The human environment, riparian ecosystem and the biological habitat in the rivers and floodplains are thus disrupted or destroyed. Therefore, river bank erosion has been identified as a type of disaster in Bangladesh.

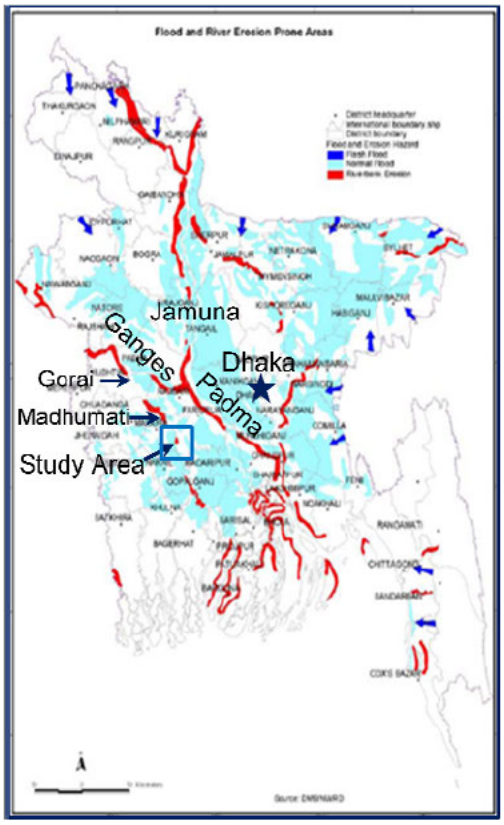


Fig. 1 River bank erosion and flood prone areas

Difficulties in river bank erosion control in Bangladesh arise both from economical or financial and technological reasons. Economic and financial constraints appear due to very low return from the investment. This implies that only the priority sites can be brought under structural measures. However the location and extent of bank erosion is not yet predictable in reasonable time ahead. Some difficulty for evaluating bank erosion hinders the proper planning for river management. Therefore, topics associated with channel shifting and bank erosion is chosen for present study. Present research is aimed to test the possibility of using a mathematical model, based on river mechanics principles, as a tool to assess the migration characteristics of meandering rivers.



Fig. 2 Location of study area

STUDY AREA

The Madhumati River originates from the Ganges River and its channel length is 199 km. It passes through the south-western region in Bangladesh. The Madhumati River showed a typical meandering behavior and migrated very actively throughout the period of record. The study area is Mallikpur bend on the river (Figure 2). It is approximately 1.88 km long. The bend is becoming

sharp year by year resulting from severe bank erosion. The river has shown a tendency to coincide with the neighboring Naboganga River through this bend. The morphological changes of the river are shown in Figure 3. In 1973, the shortest distance between these two rivers was 3.85 km. This distance has been reduced to 2.64 km in 1984 and 1.7 km in 1997 (Sarker et al. 1999). The meander bend migration is still active. The reach has shown a considerable amount of migration for latest several years.

METHODOLOGY

Local scouring and bed topography in curved channels of constant curvature with non-erodible banks were studied in order to obtain important results for river improvement works. Models developed by Engelund (1974) and by Ikeda (1974) were reviewed and applied to local scouring to test their validities (Table 1). Secondary flow is the key factor for the asymmetric cross-sectional profiles in curved channels. In those models, the secondary flow plays an important role on the relation among the direction of sediment particle migration, direction of fluid force and transverse bed slope and is taken into account through the transverse bed slope parameter. Application of the methods is conducted assuming fully developed flow in the meander bend. The width of the equivalent rectangular channel was estimated from the bankfull geometry and flow properties using a definition equation as $B_{eq} = Q/(UH)$ and found equal to 287m. The channel centerline curvature was obtained from planform analysis of satellite images and estimated to be 0.00148/m (radius = 677m). In order to apply Engelund's model, the transverse bed slope parameter A was supposed to be 4 according to his experimental results. Whereas a calibrated value of A was 6 in Ikeda's model. With this calibrated value, the best possible agreement is obtained between the calculated and the measured bed topography.

The meandering channel migration process results from the interaction between flow, sediment transport and bank erosion as shown in Figure 4. Linearized 1-D models are widely used to simulate morphodynamic processes of natural meandering rivers. The meander migration models proposed by Ikeda et al. (1981) and by Hasegawa (1989) are reviewed and applied to channel shifting to test

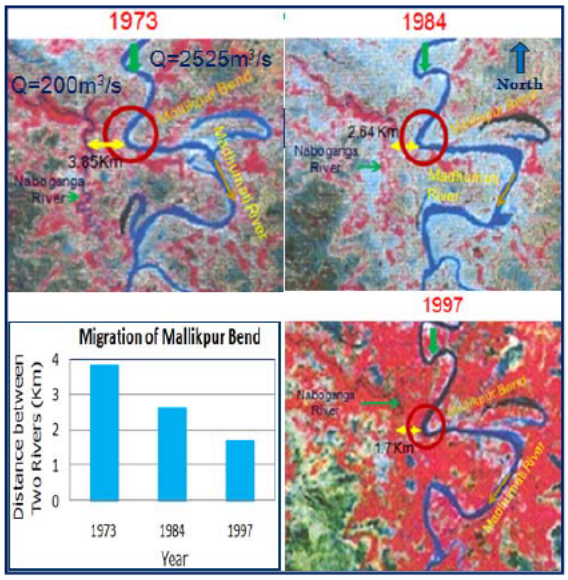


Fig. 3 Morphological changes of the Madhumati River

Table 1 Overview of bed topography models

Engelund (1974)	$\frac{\eta}{H} = \left(\frac{\tilde{r}_0 + \tilde{n}}{\tilde{r}_0}\right)^A - 1$
Ikeda (1974)	$\frac{\eta}{H} = \exp\left\{\frac{1}{2}A\left(\frac{\tilde{r}^2}{\tilde{r}_a{}^2} - 1\right)\right\} - 1$

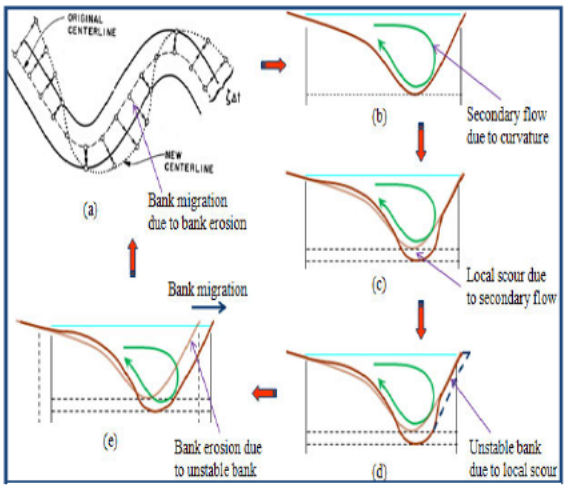


Fig. 4 Bank migration process: (a) planform of a meandering channel (Johannesson and Parker, 1985); (b) secondary flow is generated due to channel planform curvature; (c) secondary flow carries the near bottom sediment from the outer bank to the inner bank region in the downstream and progressively local scour takes place; (d) the outer bank is undermined and becomes unstable; and (e) unstable bank collapses, and causes bank erosion. Finally the outer bank migrates.

their validities for river management. Ikeda et al.'s model is based on shallow water (St. Venant) flow model coupled with the assumption that bank erosion rate is linearly related to the near-bank excess velocity. Hasegawa's model, which is based on the same linear relation as Ikeda et al.'s, includes the erosion rate formula that is derived from integration of sediment continuity equation. Three different numerical simulations are carried out using meander migration models; methods 1 to 3 (Table 2).

In the meander migration models, near-bank excess velocity u is computed by the linear solution of the flow field (Eq. 1).

$$u = -\chi C(s) + \int_0^S C_f \left\{(A+2)\chi^2 + F^2\chi^5\right\} C(s') \exp\left\{-2\chi C_f (s-s')\right\} ds' \quad \ldots(1)$$

The parameter χ, which is the cube root of the ratio of the equivalent straight channel length aligned along the valley axis to the meandering channel length, is computed using the channel centerline coordinates. The spacing of the digitized coordinates is of one width-equivalent.

In Method-1, the erosion coefficient is calculated for the period 2002 to 2004 from the map of time sequential bank line diagrams. Bankfull geometry and flow parameters are used as input data (Table 3). The time step equal to 0.25 years is employed in the computations. In addition to bankfull geometry and flow parameters, sediment characteristics and transport parameters are required by Method-2 (Table 4). The time step is specified as the duration of bankfull discharge of different flood events. In Method-3, observed near-bank excess flow depths are used.

RESULTS AND DISCUSSION

The results computed by Engelund (1974) and by Ikeda (1974) model are shown with the measured cross-sectional shape in Figure 5. Correspondingly, the results can be interpreted as follows: If the side bank of the reach is composed of non-erodible wall, the bed will be eroded like a predicted curve. Taking such matters into consideration, it is suggested that the transverse bed profile can be computed fairly well by Ikeda's model.

The migration models were applied to predict the migration of a meander bend of the Madhumati River and were examined by comparing the simulated results and corresponding field data

Table 2 Overview of meander migration methods

Method	Equation	Comments
Method -1	$\zeta = E_0 u$	$E_0 = \frac{\sum_{i=1}^{n}(u_i \cdot \zeta_i)}{\sum_{i=1}^{n}(u_i)^2}$
Method -2	$\zeta = E_0 u$	$E_0 = \sqrt{C_f}\,\chi^3 I_0 \left[\frac{3KT\tan\theta_k}{(1-\lambda)\left(\frac{\rho_s}{\rho}-1\right)\sqrt{\emptyset_*}}\right]$
Method -3	$\zeta = E_0\left\{u - \chi^2\left(\frac{1}{6}+\frac{1}{3\emptyset_*}\right)\frac{\eta}{H_0}\right\}$	$E_0 = \sqrt{C_f}\,\chi^3 I_0 \left[\frac{3KT\tan\theta_k}{(1-\lambda)\left(\frac{\rho_s}{\rho}-1\right)\sqrt{\emptyset_*}}\right]$

Table 3 Bankfull geometry and flow parameters

Parameter	Meander Channel	Equivalent Straight Channel
Bankfull discharge	$Q = 2525\text{m}^3/\text{s}$	$Q = 2525\text{m}^3/\text{s}$
Average channel top-width	$B = 470$ m	$B = 470$ m
Average channel bed slope	$I = 0.00004$	$I_0 = 0.000069$
Average channel depth	$H = 8.00$ m	$H_0 = 6.655$ m
Average flow velocity	$U = 1.10$ m/s	$U_0 = 1.322$ m/s
Transverse bed slope parameter	$A = 6.00$	$A = 6.00$
Froude number	$F = 0.12417$	$F = 0.16365$
Friction factor	$C_f = 0.002594$	$C_f = 0.002576$

Table 4 Sediment characteristics and transport parameters

Parameter	Value
Median diameter of sediment particles, d	0.179 mm
Porosity of bed and bank material, λ	0.44
Transverse slope angle of eroding Bank, θ_k	26.64^0
Critical Non-dimensional Shields stress, τ_{*c}	0.073
Static Coulomb friction Coefficient of sediment particles, μ_s	1.00
Dynamic Coulomb friction Coefficient of sediment particles, μ_k	0.70
Constant of bed load transport rate, K	8.00
Density of sediment particles, ρ_s	$2650\ \text{kg/m}^3$

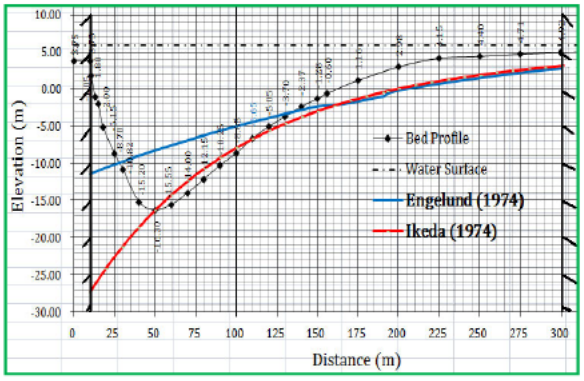


Fig. 5 Simulation of transverse bed topography: Side bank is composed of non-erodible wall.

(Figure 6). The results suggest that Method 1 & 2 are able to simulate well lateral migration, however these cannot evaluate downstream migration. Method 3 is able to simulate the downstream migration well. In this method an influence of the near-bank excess flow depth on the bank migration is added to the Method 2. Maximum velocity is predicted at the bend apex whereas the largest water depth is observed downstream of the bend apex. Although the near-bank excess velocities and observed near-bank excess flow depths were out of phase (Figure 7), they together amplified the bank migration rate. This might be a possible reason for shifting the migration towards the down-stream direction. However, this method cannot predict the lateral migration in the upstream of bend apex. It is suggested that there are two reasons for the deviations. One possible cause for the deviation was considered to be the length scale of spatial discretization. However, it is suggested that the smaller length scale of spatial discretization does not yield much better results.

The second and most important reason was considered to be the large flow width of the channel. The flow width was determined including the very shallow water zone near the inner bank in the study reach. If the flow width is estimated to be large in comparison with the real one, the near bank excess flow depth will be large. Figure 8 shows that near-bank excess flow depth effect is much larger than the near-bank excess velocity on the bank migration rate. As the near-bank excess flow depth effect was large in the upstream of bend apex, the lateral migration was over predicted. Correspondingly, the prediction of bank shifting will be improved by determining the flow width carefully.

CONCLUSION

Scouring of curved channels and migration of meandering channels are studied using existing models in order to obtain information for river management. Special attention is paid for applicability of the models to the Madhumati River in Bangladesh as well as for testing validations.

It has been found that transverse bed profile can be computed fairly well by the model developed by Ikeda (1974). Maximum scour depth can also be predicted supposing the side bank is composed of non-erodible wall. The results show that local scour

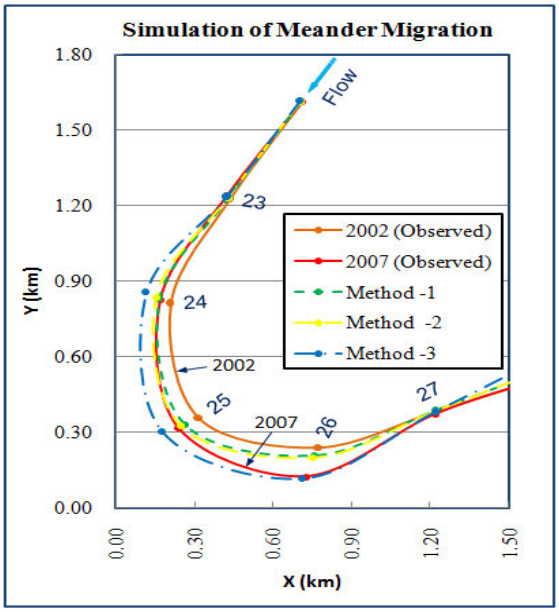


Fig. 6 Simulation of meander migration – Madhumati River (Bangladesh): The digitized coordinates of the channel centerline in 2002 is used as the initial location for simulation. The nodes are numbered to facilitate further discussion in Figure 7 and 8. Channel centerlines as predicted in 2007 by method 1, 2 & 3 are shown with the dashed, long-dashed and long-dash-dotted lines. Predicted channel centerlines are compared with the observed location in 2007.

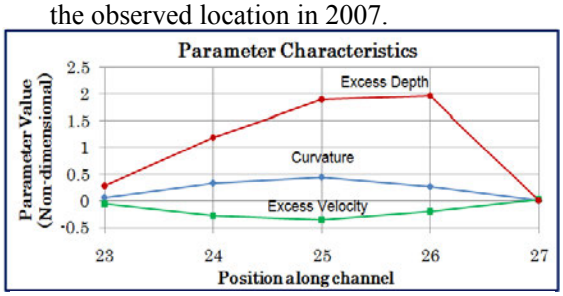


Fig. 7 Parameter characteristics: X-axis is position in bend measured downstream in width-equivalent units. Y-axis is non-dimensional local curvature, near-bank excess velocity and near-bank excess flow depth. Non-dimensional near-bank excess velocity is predicted by Eq. (1). Curvature is half-width normalized. The near-bank excess flow depth is measured and normalized by H_0. Curvature is defined as positive for anticlockwise turning of river channel, viewing from upstream. Curvature and near-bank excess velocities have opposite sign. Therefore, bank migration is directed towards outer bank. Node no. 25 is the bend apex.

depths in meandering channels can be evaluated roughly and efficiently by means of such simple methods.

It is found that the meander migration models proposed by Ikeda et al. (1981) and by Hasegawa (1989) could be acceptable for evaluating the channel shift although some improvements may be necessary. Specially, Hasegawa's model will predict well the bank erosion and corresponding channel shift if the flow width is specified carefully. Since the cross-sectional shapes of rivers in Bangladesh are highly asymmetric, special attention is necessary to determine the flow width. In this way it is possible to improve the predictions. Nevertheless, such meander migration models provide a valuable and easy-to-use tool to analyze migration characteristics of meandering channels.

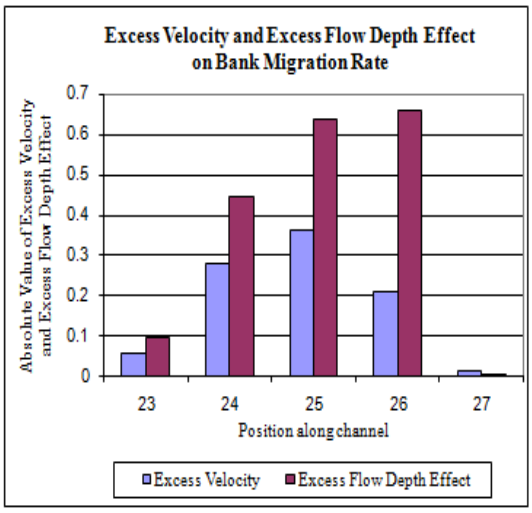


Fig. 8 Excess velocity and excess flow depth effect on meander migration: X-axis is position in bend measured downstream in width-equivalent units. Y-axis is absolute value of non-dimensional near-bank excess velocity and near-bank excess flow depth effect. Non-dimensional near-bank excess velocity is predicted by Eq. (1). Non-dimensional near-bank excess flow depth effect is computed as $\chi^2\left(\frac{1}{6}+\frac{1}{3\emptyset_*}\right)\frac{\eta}{H_0}$.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Professor Shinji Egashira for his encouraging support and guidance throughout the study. My deep appreciation goes to Dr. Atsuhiro Yorozuya who has constantly encouraged me, worked hard side by side with me and made all this possible.

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A METHODOLOGICAL STUDY TO IMPROVE FLOOD MANAGEMENT OF THE TAIHU LAKE BASIN

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ABSTRACT

The Taihu Lake Basin is facing a rapid socio-economic development, and already become one of the most developed areas in China. However, its flat terrain and rapid development lead to great challenges in water resource management. This study aims to improve the flood management of this lake basin. Subsequently, two sub-objectives are set up: assess and improve the non-structural measures for flood management and study on best practices of Japanese experiences on Integrated Lake Basin Management (ILBM). In order to achieve the objects of this study, at first the challenges of flood management in the Taihu Lake Basin are clearly identified. Subsequently, "flood dispatching method" is introduced as an effective non-structural measures for flood management. In this method the relationship among the water level of the Taihu Lake, the water level of the downstream area, and the discharge of structures, become the focusing point. A 1-D flood routing model (SDRHM) is developed by discretizing St. Venant unsteady flow equations using an implicit four points numerical scheme. An innovational model inter-comparison of the SDRHM, the U.S. Army Corps of Engineers' River Analysis System (HEC-RAS), and the Taihu Lake Basin Hydrodynamic Model (TLBHM) has been done for different river systems. The model inter-comparison result illustrates that the TLBHM has advantages to other models and it is appropriate to simulate the hydrodynamic phenomena in the Taihu Lake Basin. By using TLBHM, nine different scenarios for flood dispatching method were set up and simulated. The simulation results clearly show that the dispatching method is actually balancing flood risk along the river-lake system by distribution of the risk. However it has been learned that flood risk cannot be smoothly eliminated by this kind of non-structural methods only. Moreover, a case study of the application of ILBM has been done in two Japanese lakes, the Biwa Lake and the Kasumigaura Lake. Inter-comparisons of characteristics of the lakes and their basins are also implemented, which will help to develop proposals toward application of ILBM in the Taihu Lake Basin.

Keywords: Flood Management, Unsteady flow, River Network Hydrodynamic Modeling, Integrated Lake Basin Management, Taihu Lake Basin

INTRODUCTION

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Floods have a history as long as human being. There are many factors which can trigger a flood disaster. To a hydrologist, a flood is simply a discharge rate in a stream or a river that exceeds an 'acceptable' threshold value, and is often an expression of the variability of rainfall in the river catchment (P. P. Mujumdar, 2001). Lakes are usually considered as huge natural flood retarding areas, in order to secure the surrounding areas, especially the downstream areas, during floods. However, for flood in a lake basin , water level becomes an important indicator. It is normally considered that once the water level of the lake exceeds an 'acceptable' threshold value, flood occurs and all the stakeholders should be ready to implement counter-measures.

The capacity of a lake in a flood situation is determined by its natural characteristics and also influenced by strong winds over the water surface. Unregulated human activities could also result in lake degradation and trigger related negative influences on retarding capacity of a lake during flood.

On the other hand, it has been proved that it is not suitable to consider only the lake itself while implementing management activities. As the concept of Integrated Lake Basin Management (ILBM) says, the lake basin should be considered as a whole while takes into account the biophysical features of lake basins as well as managerial requirements for lake basin systems. It is quite necessary to improve flood management by the advances of ILBM.

STUDY AREA

Yangtze Delta Urban Agglomeration is the world's No. 6 urban agglomeration, which is also the No. 1 urban agglomeration in China. Comparing with other five urban agglomerations in the world, it is comparatively weak in economic contribution, but it plays a very important role in the development of China. Taihu Lake Basin, which locates at the core position of Yangtze Delta, covers more than half of the area of the Yangtze Delta Urban Agglomeration, and includes the four most important cities. In order to obtain a sustainable development, water resources are of vital importance.

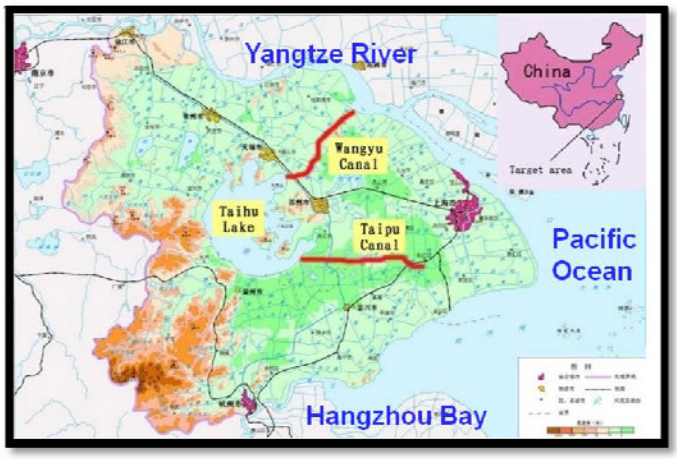


Fig. 1 Taihu Lake Basin

Taihu Lake situates at the center of the lake basin. It occupies a large share of the water within the basin, and its optimum water level is from 3.0 m to 3.5 m. The water level lower than 3.0 m is considered a dry year and if it goes to more than 3.5 m there is risk of flooding. As a large amount of population settles in the basin and a large amount of national GDP is contributed from the basin, only 0.5 m of suitable fluctuation range makes it very vulnerable to both flood and drought disasters. Moreover, More than 80% of the basin area is plain area with complicated river networks. Its river length reaches 120,000 km, making a river density of 3.25 km/ km^2, which is the highest in China. Due to its flat

terrain, complicated river networks, and the affect of surrounding tidal, the downstream rivers flow slowly and sometimes flow adversely. After concentrated rainfall, inflow discharge of the Taihu Lake would easily exceeds outflow discharge, making the water level of the lake rise quickly, and result in inundation of surrounding areas sooner or later.

In 2007, the basin's total amount of water resources was 17.27 billion m^3, but the amount of water usage reached 37.27 billion m^3. Besides retrench and re-use of water resources, the basin authority transfers water from the Yangtze River into the Taihu Lake Basin every year. Normally, the total transferring quantity could reach 2 billion m^3, among which around 1 billion m^3 could be transferred into the Taihu Lake. Sometimes the transferring is implemented during summer, which is the flood season of the basin, to ensure the water quantity and sanitation. However, it increases the risk of floods at the same time.

Construction of hydraulic structures in the Taihu lake Basin may be backward to nearly a thousand years ago. After the catastrophic flood in 1991, the State Council decided to implement comprehensive rehabilitation to this lake basin. Eleven key projects had been constructed since then. Nowadays, the lake basin has formed a flood drainage system which could drain floods northward to the Yangtze River, eastward to the Huangpu River, and southward to the Hangzhou Bay. However, compared to its fast development, the flood management capability is still comparatively low.

FLOOD ROUTING MODELING AND MODELS INTER-COMPARISON

Based on the current flood control system, this study assesses and improves an important non-structural measure, "flood dispatching method", by hydrodynamic modeling. The flows in natural rivers are normally unsteady flow, whose flow conditions vary with time at a discrete location. Both continuity equation (conservation of mass) and momentum equation (essentially, Newton's second law of motion), which are put together to form the St. Venant Equations, are used as governing equations for one dimensional unsteady open channel flow. In differential form, the equations could be written as: (The following part of this section takes (Wang, 1989) as reference)

$$\begin{cases} \dfrac{\partial A}{\partial t} + \dfrac{\partial Q}{\partial x} = q & (1) \\ \dfrac{\partial Q}{\partial t} + \dfrac{\partial}{\partial x}\left(\dfrac{Q^2}{A}\right) + gA\dfrac{\partial H}{\partial x} + gA\dfrac{Q|Q|}{K^2} = qV_x & (2) \end{cases}$$

where, A: area of cross-section; t: time interval; Q: flow rate; x: distance between crosess-sections; q: the lateral inflow per unit length of channel; g: gravity acceleration; H: water surface level; K: conveyance, $K = \frac{1}{n}AR^{2/3}$; n: Manning's coefficient; R: hydraulic radius; V_x: velocity of the lateral inflow in the x direction.

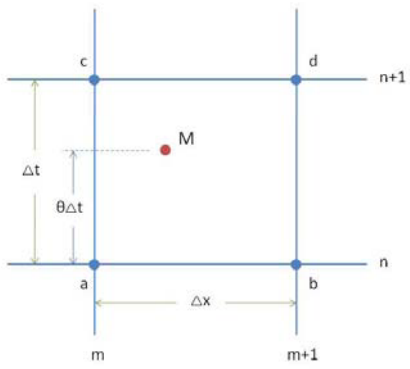


Fig. 2 Preissmann Four Points Implicit Scheme

Usually, V_x is considered as 0, and the lateral inflow could be avoided by dividing the rivers at the junction points. Here, Preissmann four points implicit scheme is used for discretizing the equations.

As shown in Fig. 2.2, the values of point a and point b are

known and the values of point c and point d are unknown for each calculation step. The value of arbitrary point M could be expressed as:

$$f(M) = f(x,t) = \frac{\theta}{2}(f_{m+1}^{n+1} + f_m^{n+1}) + \frac{1-\theta}{2}(f_{m+1}^{n} + f_m^{n}) \tag{3}$$

where, θ: time weighting coefficient, $0 \le \theta \le 1$, introduced in the spatial derivatives to aid in the numerical solutions.

If consider $f^{n+1} = f^n + \Delta f$, the following expressions could be derived:

$$f(x,t) = \frac{\theta}{2}(\Delta f_{m+1} + \Delta f_m) + \frac{1}{2}(f_{m+1}^{n} + f_m^{n}) \tag{4}$$

$$\frac{\partial f}{\partial x} = \theta\frac{\Delta f_{m+1} - \Delta f_m}{\Delta x} + \frac{f_{m+1}^{n} - f_m^{n}}{\Delta x} \tag{5}$$

$$\frac{\partial f}{\partial t} = \frac{\Delta f_{m+1} + \Delta f_m}{2\Delta t} \tag{6}$$

Applying equations (4) ~ (6) into equations (1) ~ (2), they yield a nonlinear system as (7) ~ (8):

$$\frac{\Delta H_{m+1} + \Delta H_m}{2\Delta t} + \frac{2}{\theta(\Delta B_m + \Delta B_{m+1}) + (B_m^n + B_{m+1}^n)}\left[\theta\frac{\Delta Q_{m+1} - \Delta Q_m}{\Delta x} + \frac{Q_{m+1}^n - Q_m^n}{\Delta x}\right] = 0 \tag{7}$$

$$\begin{aligned}
&\frac{\Delta Q_{m+1} + \Delta Q_m}{2\Delta t} + \frac{\theta}{\Delta x}\left[\frac{(Q_{m+1}^n + \Delta Q_{m+1})^2}{A_{m+1}^n + \Delta A_{m+1}} - \frac{(Q_m^n + \Delta Q_m)^2}{A_m^n + \Delta A_m}\right] + \frac{1-\theta}{\Delta x}\left[\frac{(Q_{m+1}^n)^2}{A_{m+1}^n} - \frac{(Q_m^n)^2}{A_m^n}\right] \\
&\quad + \left[\frac{g\theta}{2}(\Delta A_{m+1} + \Delta A_m) + \frac{g}{2}(A_{m+1}^n + A_m^n)\right]\left[\frac{\theta}{\Delta x}(\Delta H_{m+1} - \Delta H_m) + \frac{1}{\Delta x}(H_{m+1}^n - H_m^n)\right] \\
&\quad + \frac{g\theta}{2}\left[\frac{(A_{m+1}^n + \Delta A_{m+1})(Q_{m+1}^n + \Delta Q_{m+1})|(Q_{m+1}^n + \Delta Q_{m+1})|}{(K_{m+1}^n + \Delta K_{m+1})^2}\right. \\
&\quad \left. + \frac{(A_m^n + \Delta A_m)(Q_m^n + \Delta Q_m)|(Q_m^n + \Delta Q_m)|}{(K_m^n + \Delta K_m)^2}\right] \\
&\quad + \frac{g(1-\theta)}{2}\left[\frac{A_{m+1}^n Q_{m+1}^n |Q_{m+1}^n|}{(K_{m+1}^n)^2} + \frac{A_m^n Q_m^n |Q_m^n|}{(K_m^n)^2}\right] = 0
\end{aligned} \tag{8}$$

By introducing Taylor's Series and neglecting some small elements, two linear equations could be derived as (9) and (10).

$$A_{1m}\Delta Q_m + B_{1m}\Delta H_m + C_{1m}\Delta Q_{m+1} + D_{1m}\Delta H_{m+1} = E_{1m} \tag{9}$$

$$A_{2m}\Delta Q_m + B_{2m}\Delta H_m + C_{2m}\Delta Q_{m+1} + D_{2m}\Delta H_{m+1} = E_{2m} \tag{10}$$

where, $A_{1m} = -\frac{4\theta\Delta t}{\Delta x(B_m^n + B_{m+1}^n)}$, $B_{1m} = 1 - \frac{4\theta\Delta t(Q_{m+1}^n - Q_m^n)}{\Delta x(B_m^n + B_{m+1}^n)^2}\frac{dB_m^n}{dH_m^n}$, $C_{1m} = \frac{4\theta\Delta t}{\Delta x(B_m^n + B_{m+1}^n)}$, $D_{1m} = 1 - \frac{4\theta\Delta t(Q_{m+1}^n - Q_m^n)}{\Delta x(B_m^n + B_{m+1}^n)^2}\frac{dB_{m+1}^n}{dH_{m+1}^n}$, $E_{1m} = -\frac{4\Delta t}{\Delta x(B_m^n + B_{m+1}^n)}(Q_{m+1}^n - Q_m^n)$, $A_{2m} = 1 - \frac{4\theta\Delta t}{\Delta x}\left(\frac{Q_m^n}{A_m^n}\right) + 2g\theta\Delta t\frac{A_m^n|Q_m^n|}{(K_m^n)^2}$,

$B_{2m} = \frac{\theta\Delta t}{\Delta x}\left[\frac{2(Q_m^n)^2 B_m^n}{(A_m^n)^2} - g(A_{m+1}^n + A_m^n) + g(H_{m+1}^n - H_m^n)B_m^n\right] + g\theta\Delta t\frac{Q_m^n|Q_m^n|}{(K_m^n)^2}\left[B_m^n - \frac{2A_m^n}{K_m^n}\frac{dK_m^n}{dH_m^n}\right]$,

$C_{2m} = 1 + \frac{4\theta\Delta t}{\Delta x}\left(\frac{Q_{m+1}^n}{A_{m+1}^n}\right) + 2g\theta\Delta t\frac{A_{m+1}^n|Q_{m+1}^n|}{(K_{m+1}^n)^2}$, $D_{2m} = \frac{\theta\Delta t}{\Delta x}\left[-\frac{2(Q_{m+1}^n)^2 B_{m+1}^n}{(A_{m+1}^n)^2} + g(A_{m+1}^n + A_m^n) + g(H_{m+1}^n - H_m^n)B_{m+1}^n\right] + g\theta\Delta t\frac{Q_{m+1}^n|Q_{m+1}^n|}{(K_{m+1}^n)^2}\left[B_{m+1}^n - \frac{2A_{m+1}^n}{K_{m+1}^n}\frac{dK_{m+1}^n}{dH_{m+1}^n}\right]$, $E_{2m} = \frac{\Delta t}{\Delta x}\left[-\frac{2(Q_{m+1}^n)^2}{A_{m+1}^n} + \frac{2(Q_m^n)^2}{A_m^n} -\right.$

$$g(A^n_{m+1} + A^n_m)(H^n_{m+1} - H^n_m)\Big] - g\Delta t\left[\frac{A^n_{m+1}Q^n_{m+1}|Q^n_{m+1}|}{(K^n_{m+1})^2} + \frac{A^n_m Q^n_m|Q^n_m|}{(K^n_m)^2}\right]$$

For a river system, the number of unknowns would always be more than the number of equations by two. Thus, once the boundary conditions of the upstream and downstream are satisfied, the hydrodynamic of the whole river system could be simulated. The SDRHM is developed based on the understanding of the mechanism of unsteady flow. Subsequently, the SDRHM, the HEC-RAS, and the TLBHM are inter-compared by different river conditions.

In the first step, the hydrodynamics of a single river with different cross-section shapes are simulated by the three models. The results show that the three models have similar final outputs. However, due to the iteration method of SDRHM, it takes longer time before the water level become stable. Thus, HEC-RAS and TLBHM are selected to implement the simulations of river networks afterwards.

The second step of the inter-comparison is done by a simple river network, as shown in Fig. 4. The simulation results are still can be considered as completely same. However, the TLBHM is faster and more appropriate to be applied to the Taihu Lake Basin.

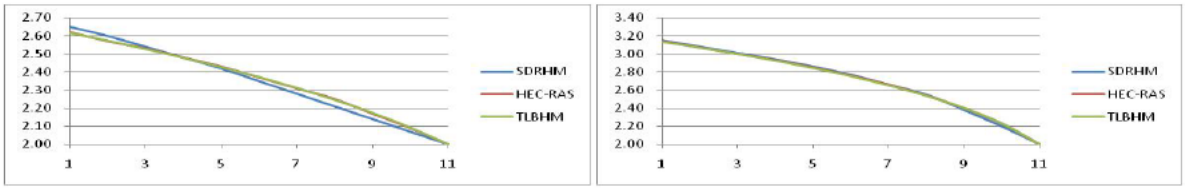


Fig. 3 Simulation Results of the Single River (Rectangle Cross-Section and Trapezoid Cross-Section)

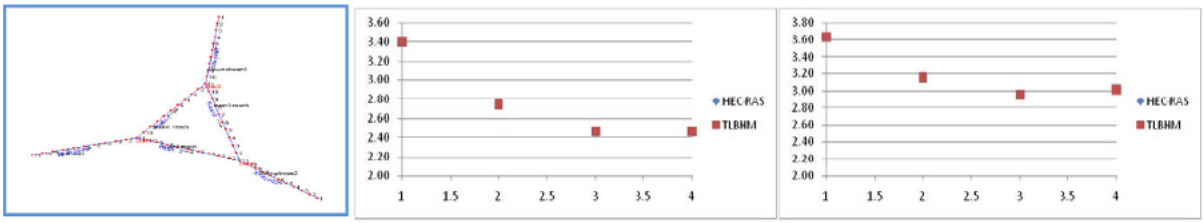


Fig. 4 Interface and Simulation Results of the Simple River Network (Same downstream condition and differed downstream conditions)

TAIHU LAKE BASIN HYDRODYNAMIC MODEL AND SIMULATION RESULTS

Floods are always historical scenarios which are not possible and not practical to replay. Accordingly, it is not possible to pick up a better flood dispatching solution by comparing different dispatching scenarios in reality. Model simulation can solve this problem to some extent. A basin-wide hydrodynamic model can simulate historical floods, and apply different dispatching methods as different scenarios. The hydrological changes could be used to identify the influences of the different dispatching methods. TLBHM generalizes the complicated river networks with the principle that the generalized items should have the same discharge and storage capability under the same water level, once compared to the original ones.

Table 1 Generalization and Simulation for Different Areas (Jin et al., 2008)

Units	Mountainous Areas	Plain areas	Rivers	Lakes, Reservoirs, Flood retarding areas	Flood control structures

Remarks	Applied for southwest mountains, in total 10 sub-basins	Applied for northwest hilly area, in total 10 sub-basins; other plain areas, in total 16 sub-basins	Applied for 1482 rivers, with total length of 7879.4 km and 4270 cross-sections	Applied for 104 lakes, with total area of 871 km2	Applied for 168 structures

The simulation process starts from the precipitation, which would generate certain amount of runoff according to the land use data. Then, the runoff would be routed to the generalized rivers as lateral inflow and trigger hydrodynamic process in the river network subsequently.

By studying the hydrology and hydraulic of the lake basin, and taking into consideration of the mechanism of the TLBHM, it is not difficult to find out that the dispatching method is actually affecting the operation of the water conservancy structures according to different background situation. Among all of the inflows and outflows of the Taihu Lake, only Wangyu Canal and Taipu Canal are directly controlled by the Taihu Basin Authority (TBA). This study tried to keep constant discharge rate of these two canals and increase them separately to identify their influences to the water level of the Taihu Lake.

By calculating with the data of 1999-flood, the yearly hydro- dynamic process of the lake basin under different scenarios are simulated, and water level variations of the Taihu Lake and the downstream can be figured out.

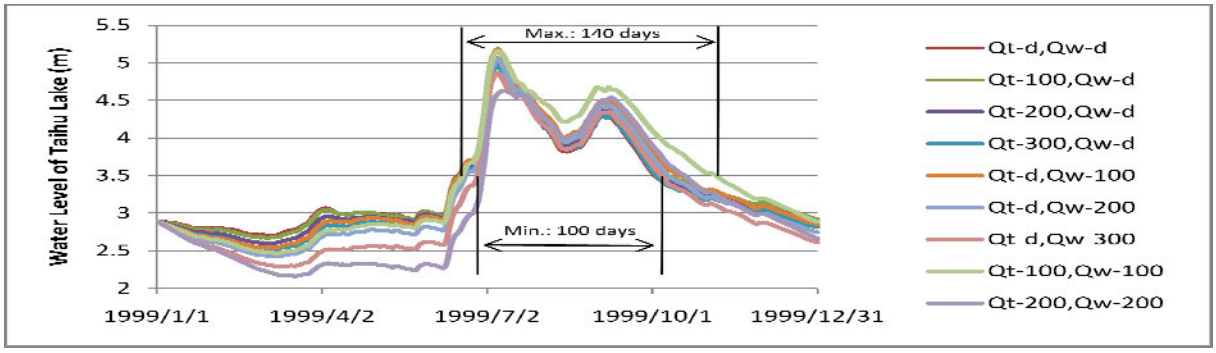


Fig. 4 Water Levels of the Taihu Lake Based on Different Simulation Scenarios (Qt: discharge rate of Taipu Canal; Qw: discharge rate of Wangyu Canal; d: the discharge is controlled according to the current dispatching method.)

CASE STUDY ON INTEGRATED LAKE BASIN MANAGEMENT

Japan is one of the countries who are suffering from different kinds of disasters, among which, flood is always considered as long threatening one, and it appears almost every year. However, benefit from the advanced management activities, Japan never had more than 700 flood victims per year since 1960s. Similarly, an Integrated Lake Basin Management has been formed to deal with the lake problems, which full-fills the demands of comprehensively managing and considering flood prevention, water resource protection, and ecological system protection at the same time. The management activities of the Biwa Lake and the Kasumigaura Lake are studied and their characteristics are compared with the Taihu Lake.

The Biwa Lake is the largest lake in Japan. It has hundreds of inflows but only one outflow. In order to protect, make full use, and keep sustainable development of the Biwa Lake, Japanese government implemented a Comprehensive Development Project for 25 years, consisting three major objectives which are the preservation measures to conserve the water quality of the Biwa Lake and the affluent

natural environment, the flood control measures to solve the flood damages around the Biwa Lake, and the water use measures to utilize the water of the Biwa Lake effectively (Biwa Lake Construction Work Office et al, 2005). Since then, levees, weirs, by-pass tunnels are constructed for different purposes, and the downstream river was enlarged and dredged. Nowadays, a unified management system, which considers the operation of both the Biwa Lake and all of the structures within the Biwa Lake and Yodo River Basin together, has been formed. During floods, the storage distribution and discharge amount of the whole system would be determined by the Yodo River Dam Integrated Control Office.

Kasumigaura Lake is the second largest lake in Japan, which is located at the downstream area of the Tone River. It has only one downstream river as outflow to the Tone River and its flood problems are related to the Tone River. For one thing, the drainage capability of the downstream of Tone River is not sufficient. After rainfall, some water would remain in the lake and difficult to drainage out. For the other thing, there is an apparent problem: the design water level of the lake is two meters lower than that of Tone River. Once flood happens in Tone River, the flood flow would enter the lake adversely due to the differences of the water levels. On the other hand, it is a shallow lake, which is easily influenced by strong winds and would result in high waves. In order to deal with these problems, its downstream river was dredged and weirs were constructed to control the discharge and prevent the backwater from the Tone River. Furthermore, wave dissipation facilities were constructed to control the high waves and protect the levees (Kanto Regional Bureau of MLIT et al, 2009).

The Taihu Lake shows some similarity with these two Japanese lakes for plenty of inflows and limited outflows. It is also influenced by high waves due to its shallow characteristic. Some advanced lake management concepts could be introduced to help the flood management of the Taihu Lake.

CONCLUSION

a) Unsteady flood analysis and the results of model inter-comparison showed that TLBHM has advantages in flood flow routing with the Taihu Lake Basin's river networks. Its less calculation time with complicated river networks and more accurate result up to round-off of three decimals make it more suitable for the daily work of flood management. Therefore TLBHM was selected and applied for the simulation of different flood dispatching methods.

b) "Flood dispatching method" has direct effect on the water level of the Taihu Lake. However, due to the limitation of drainage capability at downstream of the basin, it is actually balancing the flood risks over the Taihu Lake Basin by transferring flood risk of upstream (Lake) to the downstream area. Considering available and in operation structural measures, it is better to use the existing dispatching method as the reference and apply real-time modification by considering flood risk according to the weather forecast for precipitation.

c) Regarding ILBM concept, the lake basin should be considered as comprehensive as possible. More attentions should be paid to reduce the negative influences of human activities and try to maintain the environmental impacts during the construction of new projects. As Taihu Lake Basin is a comparatively developed region of China, the benefits of flood mitigation and water resources protection are obvious. More investments should be concentrated into the Taihu Lake Basin toward

implementation of ILBM.

d) By comparative study with Japanese ILBM cases, a centralized and basin-wide consideration of hydro-structures is suggested for Taihu Lake Basin. Moreover, in order to reduce the damage of lake waves to coastal areas and relieve the influences from high waves, constructing and operating wave dissipation structures are suggested.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Professor Kuniyoshi Takeuchi, Director of ICHARM, and Dr. Ali Chavoshian, for their continuous support and valuable suggestions. Gratefully acknowledge JICA, GRIPS and PWRI for opportunity and support of this study. I also appreciate Hohai University for providing technical support of the model.

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HYDRAULIC MODELLING OF NENJIANG RIVER FLOODPLAIN IN NORTHEAST CHINA

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MEE08181

ABSTRACT

In 1998, the worst flood recorded for over 200 years hit the Songhua River Basin and Nenjiang River Basin from June to August, covering the area of 137,000 km2. The magnitude and severity of the flood had threatened large cities surrounding these two rivers and gravely affected other urban and rural areas.

In this study, two-dimensional hydraulic models of Nenjiang River were established to model the design 100- and 200-year floods. One global model for the whole river and five other locals for the vulnerable sections were established. The global model was developed for the purpose of calibrating and validating the parameters and the five other local models were focused on the river sections in high potential risk of breaches or collapse.

In these local models, two scenarios of design 100- and 200-year floods were simulated. The flood information such as water level, discharge, current max velocities and average velocities were calculated, which could be used to help finding the vulnerable and risky portions of the embankments, and inundated depths in the floodplain were also calculated.

Keywords: Hydraulic models, Embankments, Flood information

INTRODUCTION

According to the available statistics, the dikes of the main rivers in Songliao Basin have a length of 3,270 km. The design flood control standards of some existing dikes are lower than the standards established by related authorities. Among these, such as Shuangyang River and Wuyuer River basins, the design flood control standard is only of 5 to 10 years.

The flood control capacity of some existing dikes does not meet the standard of design flood fighting capacity. The height of a large number of dikes are lower than the high warning water level, and worse still, some of the dikes are built with loose earth or sands. As they had been built a long time ago, the quality has become worse, and further aggravating the vulnerabilities or risk of breaches.

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Flood control structures and dikes are vulnerable and easily damaged by big-scale flood. Mostly the dikes in Nenjiang River Basin are composed of earth soil and sand soil; some were even built directly on sand bases. At present, the total length of sand-fill or earth-fill dikes is about 498 km, about 15% of the total length of the dikes in the Basin. Among those dikes, there is only a small fraction of the number that was protected by revetments. There is high potential risk of breach when floods occur. Therefore, the study is to find a feasible way to simulate the embankment and river issues under the impact of a flood with 2D hydraulic models.

STUDY AREA

The study area is focused on the section of Nenjiang River from the station of Ayanqian station (Ni'erji reservoir Dam) to Dalai gauging station, the length of which is approximately 600 km, including the main channel and flood plain and embankments on both sides. Figure 1.1 shows the map of the study area.



Figure 1 Map of study area

In 1998, the total rainfall was 1140 mm, which were nearly 1.9 times larger than the average (1999 to 2008) precipitation during the normal rainy season. The average rainfall of 1998 in Nenjiang River was 643 mm, 70% more than the depth in normal rainy season.The average depth of rainfall was 492.3 mm from June to August, which was 1.4 times than the historic average depth of rainfall (357.4 mm).

OBJECTIVES

The general objectives of this study are to enhance the flood prevention capacity and to reduce flood disaster of Nenjiang River Basin by building a basin wide 2D hydraulic model and other five local hydraulic models for small scale dikes. The detailed development tasks of the system are as follows:

- Collect and process the topographic data of the basin, historic and real-time hydrologic data of gauging stations of Nenjiang River
- Build the global 2D hydrodynamic model from Ni'erji to Dalai
- Calibrate and validate the coefficients by using historic flood data
- Establish local models for different sections selected from the main dikes

- Calculate different scenarios of floods and analyze the simulation

This study aims to develop hydraulic 2D models to predict flood events in both spatial and temporal aspects. The study focus is to obtain flood information on:

- Flood flow rates and water level
- Flood inundating areas
- Distribution of flow field information
- Floods risks and damage

HYDRAULIC MODELLING

In this study, a commercial software package of MIKE21 has adopted to build the global and the other five local models. It is based on the numerical solution of the two-dimensional shallow water equations - the depth-integrated incompressible Reynolds Averaged Navier-Stokes Equations.

The spatial discretization of the equations is performed using a cell-centered finite volume method (FVM). The spatial domain is discretized by subdivision of the continuum into non-overlapping elements. In the horizontal plane an unstructured grid is used comprising of triangular elements. An approximate Riemann solver is used for computation of the convective fluxes, which makes it possible to handle discontinuous solutions. For the time integration an explicit scheme is used.

Global model

In the generation of the meshes, the tools of ArcGIS and MIKE Zero are used. The basic topographic mesh is generated from the interpolation of original elevation points. Channel network and dikes were created from an existing river map. The main channels (center lines) were digitized and all necessary information was encoded including river elevation and special nodes representing locations of upper and lower boundaries or control points as source and sinks.In this model, it is assumed that in the simulation there occurs no overflow and breaches of the embankments and the embankments themselves are the solitary external boundaries. So the embankments themselves are considered as closed boundaries, meanwhile, the input and output controlling cross section in upper and lower boundaries are set as open boundaries, where the water level and discharge are given as input boundary conditions.

The input of the open upper boundary of Nenjiang River is the discharge series of Ayanqian, and the lower boundary is water level series of Dalai.

The time step also concerns the stability and accuracy of the model (DHI, 2008). Time step of the new version MIKE21 software is not constant but dynamic, which is determined by stability code under the condition of *CFL<1*.

$$CFL = \left(\sqrt{gh} + |u|\right)\frac{\Delta t}{\Delta x} + \left(\sqrt{gh} + |u|\right)\frac{\Delta t}{\Delta y}$$

Where h is the total water depth, u and v are the velocity components in the x- and y-direction, g is the gravitational acceleration, Δx and Δy are characteristic length scale in the x- and y-direction for an element, Δt is the time step interval.

In this study, the Flood and Dry parameters are set: h_{dry}=0.005 m； h_{flood}=0.05 m； h_{wet}=0.1 m.

Manning roughness coefficient is the most important parameter in the model; its value varies with the composition of riverbed and flood plain.

Calibration and validation

The 1989-year flood was used to calibrate and 1988-year flood was used to validate.

To see how well the simulated value fit the observed data, a coefficient of determination of R-Squared (R^2) was used in this study.

$$R^2 = \frac{[\sum_{i=1}^{n}(P_i - \bar{P})(O_i - \bar{O})]^2}{\sum_{i=1}^{n}(P_i - \bar{P})^2 \cdot \sum_{i=1}^{n}(O_i - \bar{O})^2}$$

Where R^2 is the square of the correlation coefficient between observed and forecasted values, $\bar{P} = \frac{1}{n}\sum_{i=1}^{n} P_i$ is the average of simulated value, $\bar{O} = \frac{1}{n}\sum_{i=1}^{n} O_i$ is the average of observed value, P is simulated value, O is observed value.

The figure 2 below shows the comparison of simulated and observed water levels in the process of calibration by using the 1989-year flood.

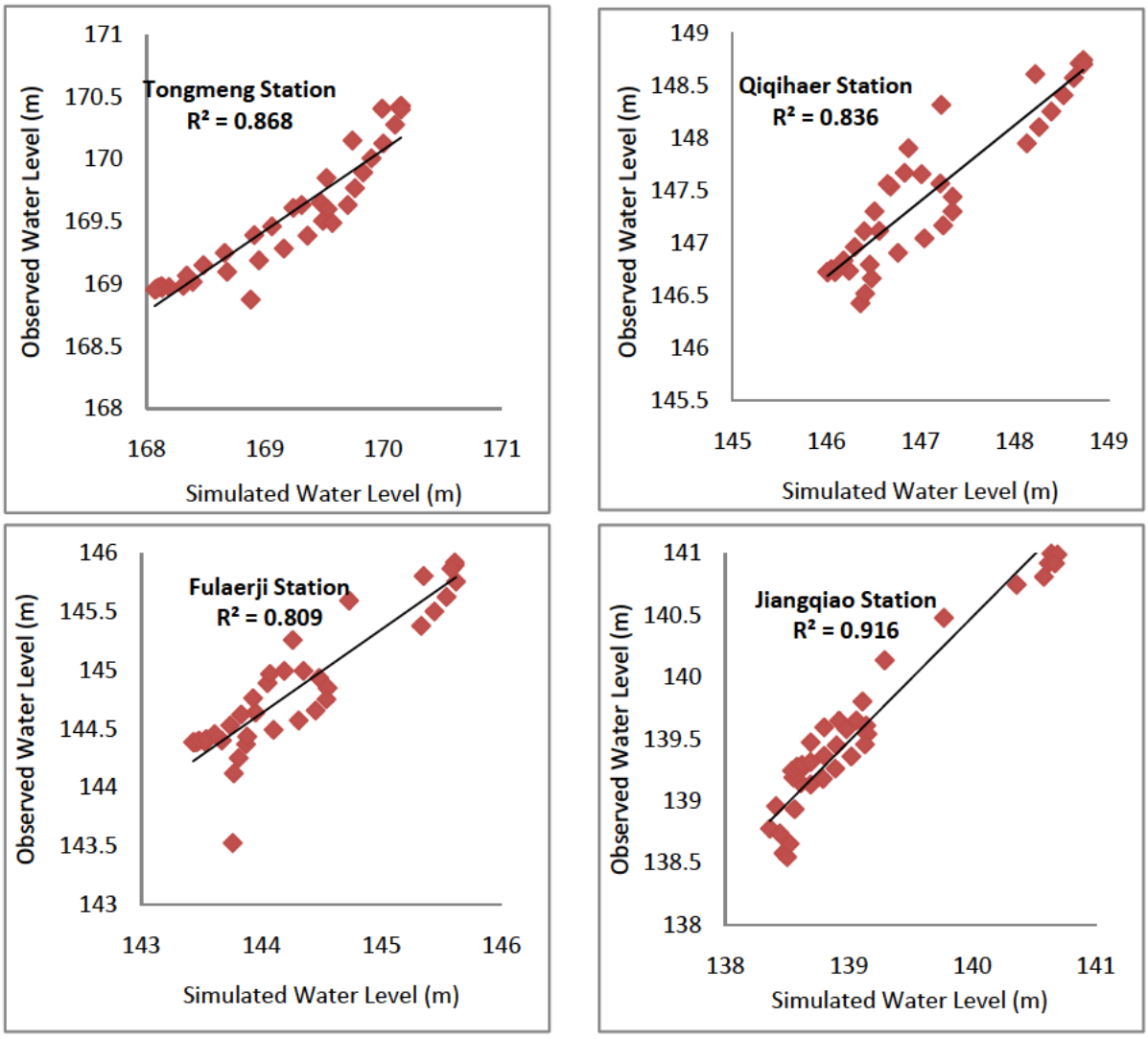


Figure 2 Comparison of simulated and observed water level of control stations by using R^2

The figure 3 below shows the comparison of simulated and observed water level in the process of validation by using the 1988-year flood.

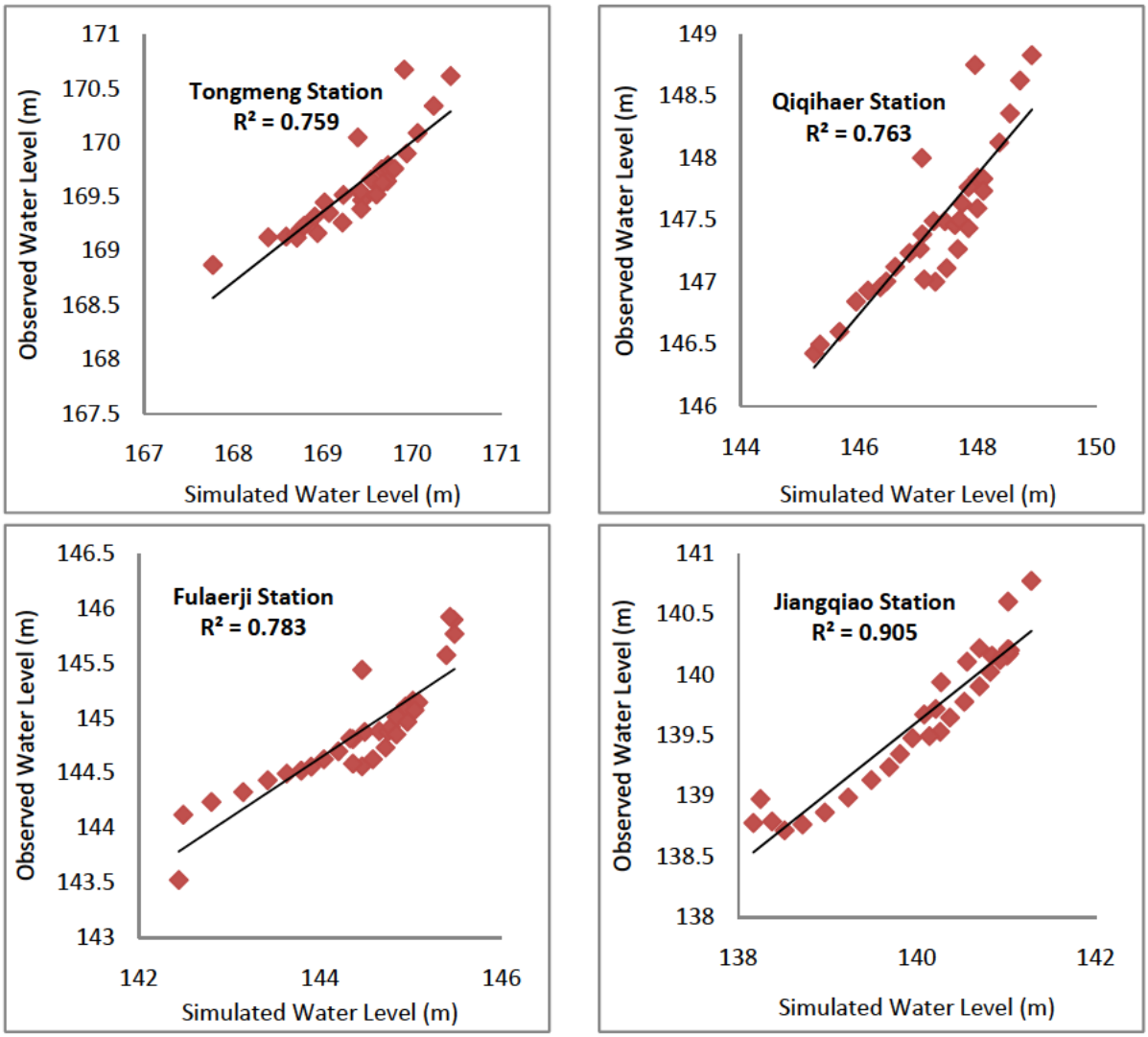


Figure 3 Comparison of simulated and observed water level of control stations by using R^2

Local Models

In the local models, smaller triangular element length was adopted, and basic principles are shown below:

- Parameters adopted in the local models are the same as those used in the original model;

Table 1 Basic information and structures of Local models

Name of Model	Total number of elements	Min. Length of elements length (m)	Max. Length of elements length (m)
Tuanjie_dike	26090	40	200
Nefu_dike	43470	16	500
Qifu_dike	24254	20	2258
Tuoli_dike	21897	60	710
Zhaoyuan_dike	30400	35	450

- Triangle elements length in flood plain should be smaller than 200 m (in the global model 800 m was used);
- Triangle elements length in main channel should be small than 50 m (in the global model 200 m was used);
- Total amount of elements be less than 50,000

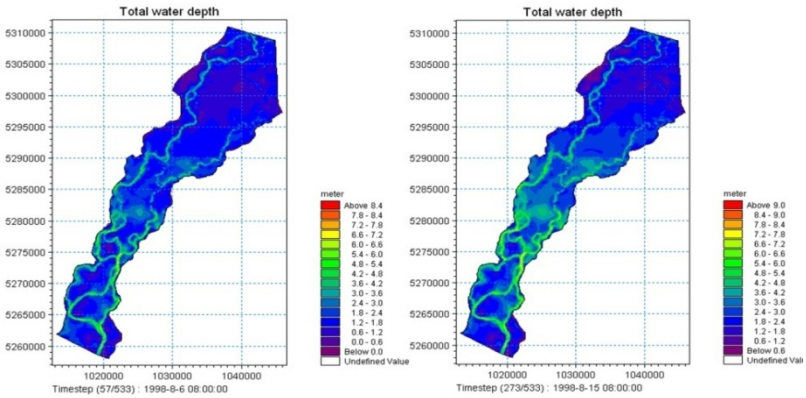


Figure 4 Comparison of the total water depth of inundated area in Qifu using design 100 year flood

CONCLUSION

A widely-accepted modelling tool, MIKE21 was applied to build the 2D model in the study, which provided a feasible module for simulating such a long river in Northeast China, which was less costly
A 2D global model covering whole study area and five local models signifying the identified high risk embankment areas were developed, and based on the simulated distribution of velocity and the depth of inundated area, vulnerable sections could be generally identified. In addition, under the high pressure of high water level, the embankments would result in pipe flow phenomena, breach, slope slide and collapse. It is suggested to carry out the slope protection works and to strengthen the dike bases. If possible, it's better to heighten the dikes or even to re-construct the existing ones.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Professor A.W. Jayawardena, ICHARM Research & Training Advisor, for his endless support, encouragement and guidance.

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SOCIO-ECONOMIC IMPACTS OF FLOODING IN DIRE DAWA, ETHIOPIA

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MEE08182

ABSTRACT

Dire Dawa, the second largest city of Ethiopia, has been suffering from disastrous floods in its history. The flooding of 6 August, 2006 was unprecedented and caused severe impacts in the city. This study focused on finding out flood causative factors and the impacts of flooding on the socio-economic sectors of Dire Dawa. To achieve the objectives the study employed trend analysis; soil conservation service curve number method (SCS-CN); Inundation analysis and ECLAC methodology. Results of the analysis showed that high intensity of rainfall accompanied by severe forest degradation has caused increased flood damage in the impact area. Moreover, the inundation result showed residential areas and business centers experienced the worst socio-economic damages among the different sectors in the city. It has also an enormous impact on the economic foundation of the city due to expenditure for rehabilitation and reconstruction. Absence of early warning system and land-use policy has contributed to the increased impact of the disaster.

Key words; Dire Dawa, Flood, Rainfall intensity, forest degradation, early warning system

INTRODUCTION

Dire Dawa, which was established in 1910 and located at the foot hills of eastern *Harerge* highlands, has been repeatedly hit by powerful flood disasters. Floods at different time have destroyed homes, public institutions, market places with their properties, infrastructures, crops in the field, livestock. In Dire Dawa, flood in August 1981 which killed about 80 people was previously considered as the worst in the town's history. However, the unprecedented August 6, 2006 flooding was worst of all cases; it surpassed all flood disasters that occurred in the past in loss of human life, and property damages.

OBJECTIVES

- ✧ To identify and assess the major flood-triggering factors in the Dechatu catchment
- ✧ To generate maps of flood inundation in Dire Dawa by using data from peak runoff events.
- ✧ To carry out a socio – economic impact survey and examine the extent of the disaster in individual and public property by using ECLAC method of disaster impact calculation.
- ✧ To generate policy relevant recommendations

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General description of the study area

Location

Dire Dawa city is located in the eastern part of Ethiopia between $9^0$27'N and $9^0$49'N latitude and $41^0$38`Eand $42^0$19`E longitude, and in the eastern marginal catchment of Awash basin (Fig 1). East *Hararge* Administrative zone of *Oromiya* Regional State borders it in the south and southeast and *Shinele* zone of Somalia Regional State in the north, east and west. Dire Dawa city is accessible by air, railway and road, and is about 500 kms road distance to the east of Addis Ababa and 311kms to the west of Djibouti port.

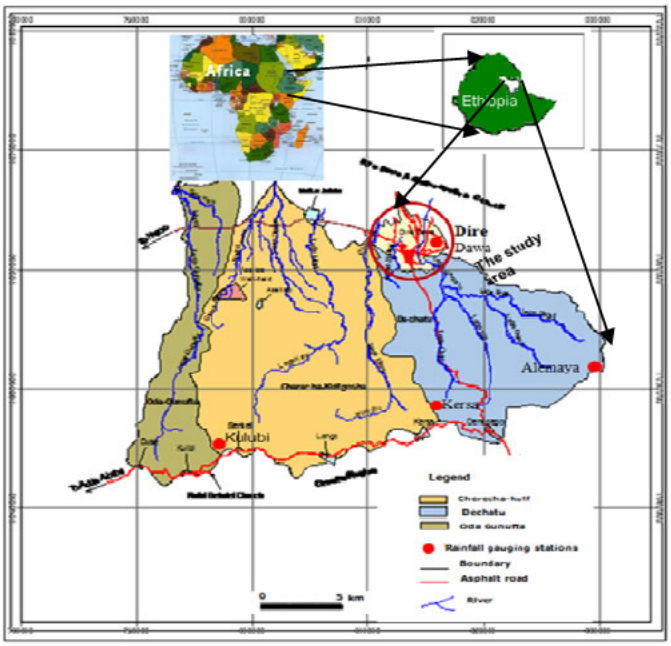


Fig.1 Study area location

METHODOLOGY

- **Trend analysis is employed to examine the trend of rainfall in the catchment**
- **Estimation of discharge data of the Dechatu River using SCS-CN method**

As no runoff data are available for Dechatu River, the Curve Number (CN) Method has been used to derive flood discharges from the rainfall data.

Hence, the peak discharge for the catchment can be calculated as,

$Q = \frac{(P - 0.2S)^2}{(P+0.8S)}$

$S = \frac{1000}{89} - 10 = 31.5\text{mm}$

$$Q = \frac{(166 - 0.2 * 31.5)2}{(166 + 0.8 * 31.5)}$$

Q=133.39mm

Where q_p=peak runoff (in cfs)

q_u=unit peak discharge (csm/in)

A_m= drainage area (mi^2)

Q= Rainfall excess (in)

F_p= pond and swamp adjustment factor

$q_p = q_u A_m Q F_p$ (USDA, 1986)

q_u=200(csm/in); A_m=55.mi^2; Q=5(in)

F_p=0.89

q_p= 200*55.5*5*0.89

q_p= 49395(cfs)= 1400m^3/s

- **Inundation Analysis**

In this study, Arc GIS 9.1 and HEC-RAS 3.1.3 have been used. HEC-RAS have been used to acquire cross-sections from DEM, to interpolate flood water levels between sections, to compute flood depth from DEM and finally flow simulation is performed and the result is exported to GIS to process the inundation map. In the Arc GIS the imported map is converted into xml file and layer is setup. Then Water surface TIN is generated. Finally, flood plain delineation is performed to calculate the flood plain boundary and inundation depth and create the inundation map.

- **Economic Commission for Latin America and Caribbean (ECLAC) method**

The Economic Commission for Latin America and the Caribbean (ECLAC) method is a tool to quantify the social, economic and environmental impacts of disaster. Based on special disaster assessment endeavors in Latin America and Caribbean region since the early 1970s, ECLAC developed an assessment methodology (ECLAC, 2003). In this study ECLAC methodology is employed to assess the direct and indirect impacts of the 2006 flooding on different economic sectors and to identify the most affected sector as well as the secondary effects of the disaster.

RESULT AND DISCUSSION

FLOOD CAUSATIVE FACTORS IN DECHATU CATCHMENT

I *Rainfall in the upland areas of Dechatu catchment*

The rainfall in all upland stations from 1995-2006 has shown decreasing trend (Fig.2). The decreasing trend of annual rainfall can be associated to the global climate change which also affects the climate of Ethiopia. Also UNDP (2007), find out that a recent trend of Ethiopian rainfall indicates a decreasing tendency in the annual rainfall in some areas.

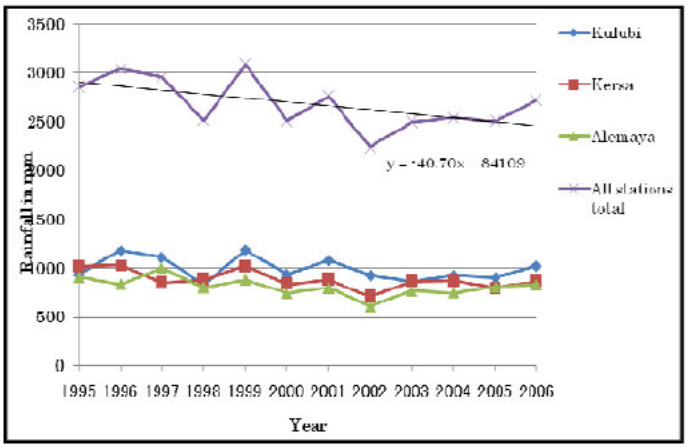


Fig. 2 Rainfall trend in upland stations of Dechatu catchment

***Note**: The line graph referring to ''all stations total'' is the sum of the total amount of rain that was recorded in each of the three upland stations from 1995 to 2006*

Although the rainfall has shown a decreasing trend, rainfall concentration in some months such as August is high. For instance in 2006 rainfall is largely concentrated during the month of August

(Fig.3) and its intense occurrence has caused worst flooding in downstream area (Table 1).

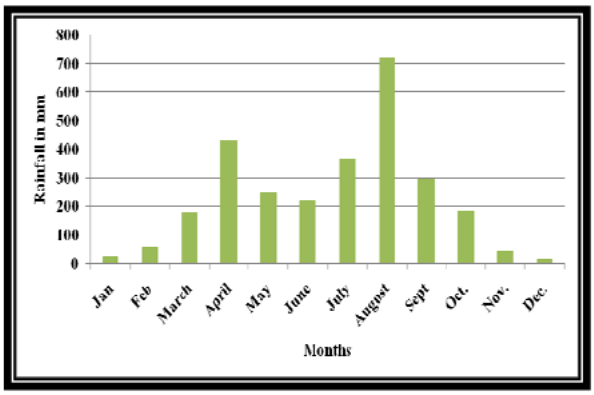


Fig.3 Monthly rainfall distribution in the upland Station (*Alemaya*, *Kersa*, and *Kulubi*) in 2006.

Table 1 Rainfall measured in upland stations

Date Aug. 2006	Dire Dawa	Kersa	Alemaya	Kulubi	Total
1	0	0	0	0	0
2	0	0	0	0	0
3	4.3	7.9	18.9	26.7	57.8
4	10.2	0	24.5	4.7	39.4
5	36.9	16 6	118	100	420.9
6	1	0	7.3	0	8.3

Note: the rainfall in August 5, 2006 in all upland areas was unusually heavy and intense that caused flooding in Dire Dawa. 67% in Kersa, 48% in Kulubi, 43% in Alemaya, and 26% in Dire Dawa of the monthly total rain fall a single day, in August 5.

II *Land-use change in Dechatu catchment*

In Ethiopia due to absence of land-use policy forest resources are utilized in abusive way.

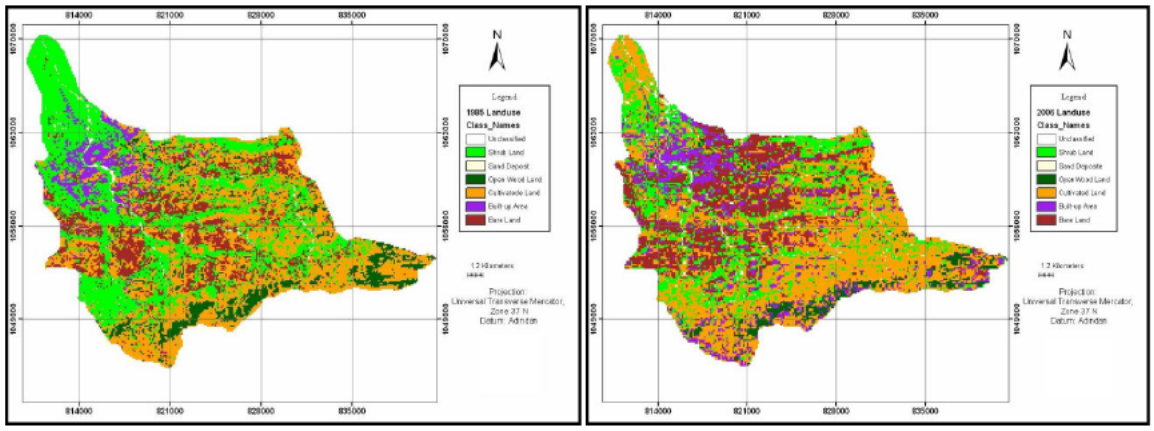


Fig 4 Land-use change map of Dechatu catchment, the years 1985 and 2006.

Referring to the 1985 and 2006 land-use map of Dechatu catchment farmland and urbanized areas are increased from 11.04% to 12.77% and from 39% to 56.33% respectively. This increase is in the expense of forestland that reduced from 18.14% to 4.19% during the same period (1985 to

2006) (Fig.4). Forestland degradation has directly correlated to surface runoff generation and increased occurrence of flooding in Dire Dawa. In this regard Calder (1999) figured out a rate of 300-800mm reduction in annual stream flow after afforestation took place in Transvaal region of South Africa. Ethiopia lacks comprehensive land-use policy that gave way to severe forest resource degradation and this in turn aggravated flooding. Similarly Bishaw (2001) pointed out that the major forestry problems in Ethiopia is absence of sound and comprehensive land-use policy.

INUNDATION AREAS OF DIRE DAWA CITY

Based on the result of the inundation analysis (Fig. 5), in the residential areas 55.9% of the total inundation area is covered by 1m inundation depth; 30% of the total inundated area is covered by 2m inundation depth. Generally, about 86% of the total inundated area is covered by 1 to 2m inundation depth. Since all of the houses in the inundated area are one storey houses, this depth of inundation could cause damage of houses and property; and cause human casualty.

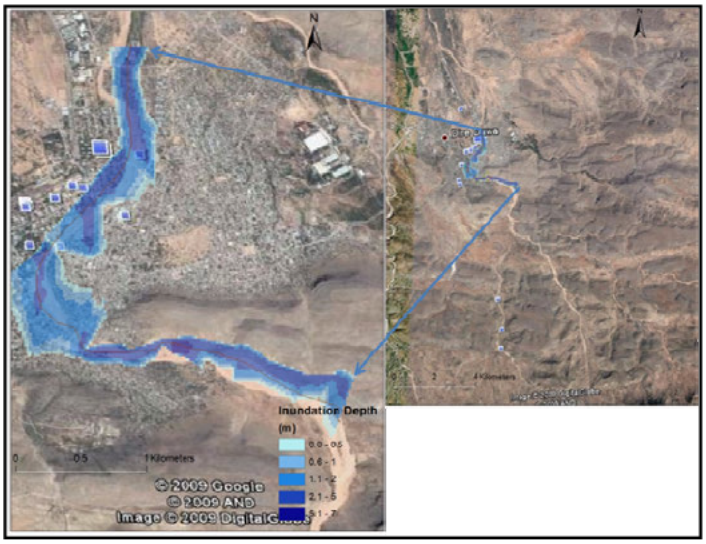


Fig. 5 Inundation map of Dechatu catchment

Note: The inundation map prepared from GIS tool is overlaid on Google map to show the inundation area of the city.

SOCIO-ECONOMIC IMPACTS OF FLOODING IN DIRE DAWA

The 2006 flood has inflicted severe direct and indirect damages on social; infrastructure and economic sectors of Dire Dawa. It caused the death of 256 people, 244 missing and 15,000 people displaced from their dwellings. Number of fatalities was large because floods hit the city in the middle of the night while people were in deep sleep and absence of early warning system that alerts the residents before the flood hit the city. Of the total fatalities, the proportions of women fatalities were 134 as compared to 83 men fatalities; and the remaining 39 fatalities were children. This is mainly due to the fact that most affected Kebele (05) is center for small scale business where women are most involved and residing in the area.

Flood in 2006 also severely damaged infrastructure and housing sector. In the housing section, a total of 1628 houses were totally and partially damaged with a total value of 10.23 million USD. The total sum of direct and indirect damages on agriculture and trade and industry sector including cost of demolition and removal of debris was about 2.6 million USD. The overall direct

and indirect disaster impacts occurred in agriculture; trade & industry; and infrastructural sector in the 2006 flooding as per the result of ECLAC calculation was 14.9 million USD. The housing sector is the most severely affected sector in the 2006 flooding in Dire Dawa.

CONCLUSION

- The increasing intensity of rainfall accompanied by forest resource degradation particularly in the upland areas of the catchment has potentially caused floods in the Dire Dawa city.
- The increased extent of the 2006 flood disaster was partly caused by lack of early warning system that could awaken the community to evacuate to safer places before the flood hit the city.
- Ethiopia lacks a comprehensive land-use policy which gave way to increased forestland degradation and this in turn contributed to increased occurrence of flood disaster in downstream areas
- The 2006 flood impact on the socio-economic sector of Dire Dawa was worst that the extent of its impact is incomparable with other flood disasters occurred in the flooding history of Dire Dawa city. Total direct and indirect impacts of flood disaster in all sectors are about 15 million USD.

ACKNOWLEDGEMENT

I would like to express my sincere appreciation and heartfelt thanks to my supervisor Prof. A.W. Jayawardena and advisor Dr. Adikari Y. who have been a constant source of assistance, encouragement, and support and guiding the right path of my work from the time the study was conceived right up to this completion. My acknowledgement also goes to Mr. Kitano, training coordinator who reviewed this paper in detail and gave me constructive suggestion.

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IDENTIFICATION OF POTENTIAL EFFECT OF ILLEGAL RESIDENCE IN FLOODPLAIN AND SOCIO-ECONOMIC EFFORTS FOR SOLUTION ~a case study of ciliwung river basin~

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ABSTRACT

As a consequent of urbanization, Ciliwung floodplain has become the favorite place for disadvantaged people. The occupation of floodplain obviously narrowing river section and as the result Ciliwung River became unable to accommodate the water from its drainage area.
In order to set the Ciliwung floodplain free from illegal residence, it is necessary to relocate people to appropriate places. Nevertheless, this effort is still facing some problems. Many obstacles and protests come from the residents. Moreover, many residences that live in floodplains are reluctant to move to the apartment with a variety of reasons that eventually make them going back to the floodplain.
In order to give contribution and to promote solution about floodplain occupation by illegal residence, this study identified scientifically the potential effects of illegal residence in floodplain by using hydrological data comparison. Furthermore, to promote the socio-economic solutions, the efforts for reducing illegal residence that area related to socio-economic conditions are analyzed based on literature review.

Keywords: Floodplain, Ciliwung River Basin, Illegal Residence

INTRODUCTION

Objectives

1. Scientific identification of potential effects of illegal residence on flood by using hydrological data comparison; such as rainfall intensity, discharge and water level in Ciliwung Basin together with population, land use and occupied floodplain area data.
2. Systematic analysis of illegal residence reduction efforts related to socio-economic conditions based on a review of related literature in order to find the way of promoting solution in reducing the growth of illegal residence.

Background

In regard to land use change, common occupation of floodplain is considered having contribution to the potential increase of floods. As the impact of urbanization, Ciliwung floodplain becomes favorite place for disadvantaged people. The occupation of floodplain obviously narrowing river section and as the result Ciliwung River became unable to accommodate water drainages to this river. Analysis on the effect of floodplain occupation is still very limited. But it is considered important since it is usually closely related to settlement of people with poverty. Solution to this problem will be related to technical as well as socio-economic matters. From the point of view of disaster management, understanding on the qualitative and quantitative effects of floodplain occupation on the increase of flood events is indispensable to give appropriate direction on the proposal of solution. As a contribution to draw the knowledge about the above matters, this thesis would like to identify the effects of illegal residence in the floodplain to the flood potential.

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In order to set the Ciliwung floodplain free from illegal residence, it is necessary to relocate people to appropriate places. Relocating the people living in floodplains along the Ciliwung River is not an easy task and even brings other problems. Problems such as facilities, price, or flats allocation are accompanying regarding to this effort. Moreover, many residents that live in floodplains are reluctant to move to the apartment with a variety of reasons that eventually make them going back to the floodplain. Along with this, cause of fast growth of illegal residence will be discussed to find the way of promoting solution in reducing that problem.

STUDY AREA IDENTIFICATION

Ciliwung River is one of the rivers that crossing the provincial administrative region through the Province of West Java and Jakarta. This river comes from Telaga Warna Pangrango at the foot of Mount Pangrango in Puncak, Bogor, and flows northwards through the cities Bogor, Depok, Jakarta and the Jakarta Bay in the estuary. The Ciliwung river basin form is long and narrow. Ciliwung river length is approximately 119 km, with basin area of approximately 476.2 km^2 and is inhabited by approximately 3.5 million people. The upstream part is dominated by hilly and mountainous topography with slope gradient 16%. Upstream elevation is located between 370 meters to 3,010 meters above sea level. The elevation in the midstream is located between 51 meters to 370 meters above the sea surface water. While for downstream area is generally dominated by flat topography with a slope gradient from 0-2%. The elevation of downstream is located between 0 meters to 51 meters above sea level.

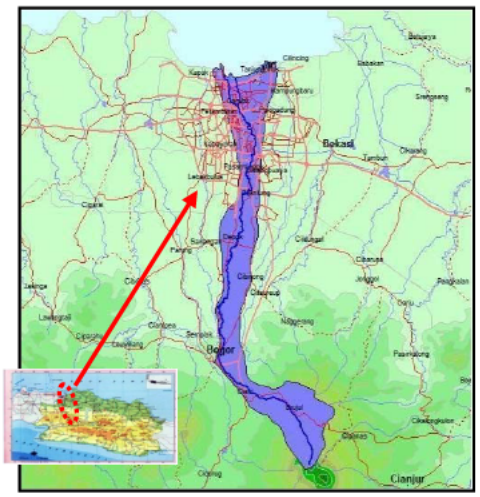


Fig. 1 Ciliwung Basin

According to the Manual Control of Space Utilization in Disaster Flood Prone Area, Directorate General of Spatial Planning Republic of Indonesia, the floodplains is land on the both side of river section along the riverbank which is measured from the river bank up to the inside of embankment toe.

Based on the Regulation of Public Works Minister No. 63 of 1993 concerning on Floodplain Line, River Utilizing Area, River Controlling Area, and Former River, function of flood plains is an area where some of river discharge can flow during the flood/high water/overflow. Accordingly, it is prohibit in the floodplains to throw trash/garbage and construct any buildings. Floodplain line of river that has embankment inside city area at least 3 m outside the embankment counted from the lower part of the embankment. This area is regulated zone. It is prohibit in this area to throw any waste; solid or liquid, and to construct permanent building for housing or business area.

Many of permanent building and simple rookery have filled floodplain along the left-right edge on Ciliwung River. Ironically, people got the permission and legal certificate to utilize Ciliwung floodplain (Pusdiklat PAP, 2007). Illegal residence occupation has reduced river effective capacity.

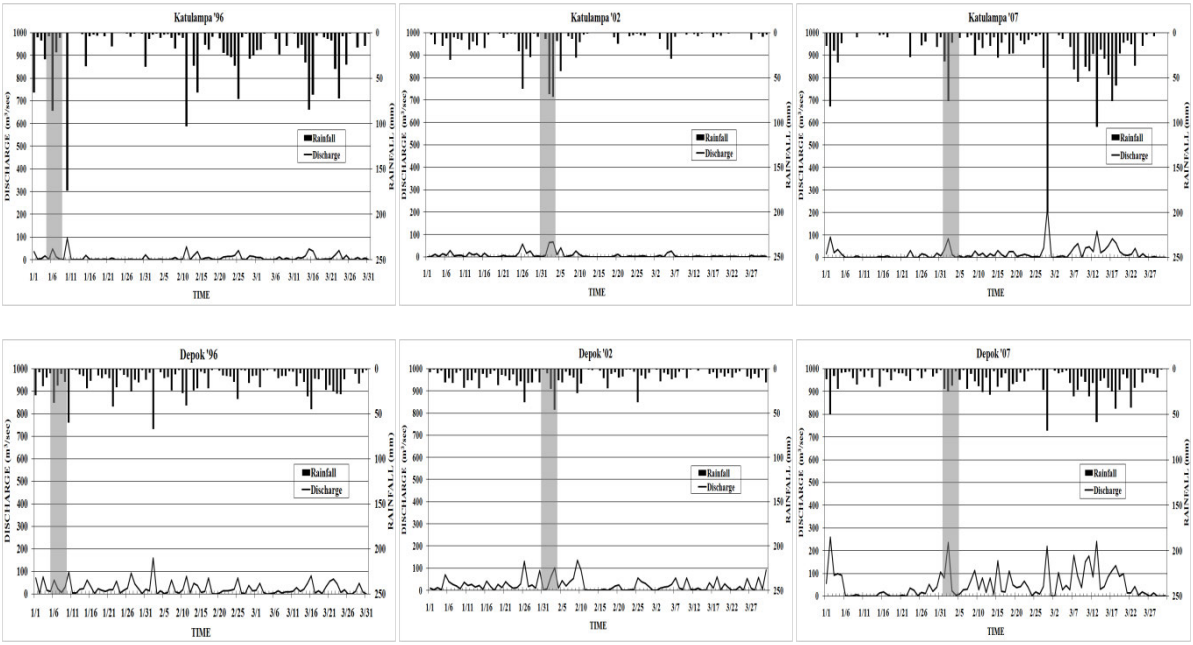
Ministry of Public Works together with Provincial Government of DKI Jakarta has carried out socio-economic efforts to solve the illegal residence in floodplain. One effort is people relocation to subsidized apartment. However, implementation of people relocation is not a simple effort. Illegal residents are reluctant to move to the new apartment due to reasonable objection. Economic factor become the basic issue.

DATA ANALYSIS

Based on census data, in the past decades the human population in Ciliwung Basin exploded from 6.4 million in 1971, 9.2 million in 1980 up to 12.3 million in 1990 and reached 13.8 million in 2000 (BPS, 2008). The city's need for additional residential space resulted in rampant housing and commercial developments as well in Bogor and Depok areas. Forests and paddy fields were quickly replaced by asphalt pavements and concrete buildings, herewith reducing the water retention capacity of the area. More rainwater is now diverted faster and directly to the nearest stream or river, thereby it may increase river peak flows and discharges.

Floods in Ciliwung basin usually occurred during January to March. The tendency of annual mean rainfall (mean catchment) from 1980 until 2007 in all sub-basin is not decreasing. Many discuss that Ciliwung floods are caused by the 'given flood' from upstream. However, the annual mean rainfalls in the upstream to downstream were actually decreasing. The tendency in those sub-basins represents that in fact there was no increasing rainfall of 'given flood' from the upstream although the highest monthly average rainfalls have occurred in the upstream.

As well as rainfall intensity, the highest discharges also occur during January-March in each stations and the lowest occur during June- August. Annually, the discharge has a tendency of increasing from 1980 to 2007. Rainfall and discharge have parallel associations, as the hydrological effect, when the rainfall intensity increases; the runoff discharge also tends to increase too. From this phenomenon it can be concluded that the floods in Ciliwung basin is not caused either by the increasing of annual rainfall and increasing discharge.



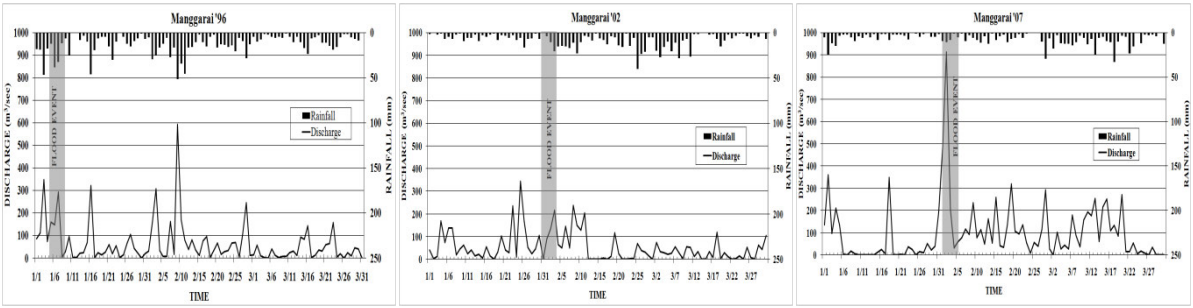


Fig. 2 Hydrograph in January - March 1996, 2002, 2007

Fig. 2 shows the change of mean catchment rainfall in Ciliwung Basin and discharge during the major flood events in 1996, 2002, and 2007. Simply analyze the hydrograph in Fig. 2 briefly shown that rainfall was decreased. The discharge in each station is increasing. The highest discharge was occurred in 2007 in each station. According to the flood history, the most severe flood was occurred in 2007. Fig. 2 shows that equivalent intensity of rainfalls sometimes cause floodings but sometimes not. In some cases higher discharges thatn those in flood events did not cause flooding. The factors that can be assumed are the possible effects of sea tide and effect of garbage accumulation at the trash rack in Manggarai Barrage. Here it is assumed that the sea tide were in normal level; there was no back water effect so that water could be drained to the sea during the high discharge. Also it is assumed that there was not high garbage accumulated in the thrash rack; when the high discharge occured garbage did not clog the water flow. Another phenomenon that found from the Fig. 2 is that after the flood events sometimes discharge was raised but there is no flood event recorded. It can be assumed that the floods washed away most of the illegal residences which occupied the floodplain. Then the river capacity returned to normal condition and during the following high discharge the floodplain could accommodate the flood water excess. To verify all the assumptions, it is necessary to collect all the data required such as sea level and garbage volume record in the next study.

Furthermore, analyses of changes of rainfall and discharge changes are explained in Fig. 3 about annual runoff ratio. The trend of runoff ratio is increasing from 1980 to 2007. The highest runoff ratio increment was found in Manggarai Barrage. Runoff ratio is comparison between discharge and rainfall. The increment of runoff ratio indicates the increase of discharge volume by rainfall. As mentioned before, the change of rainfall and discharge should be shown in a parallel relation. Increase of rainfall is in line with increase of discharge.

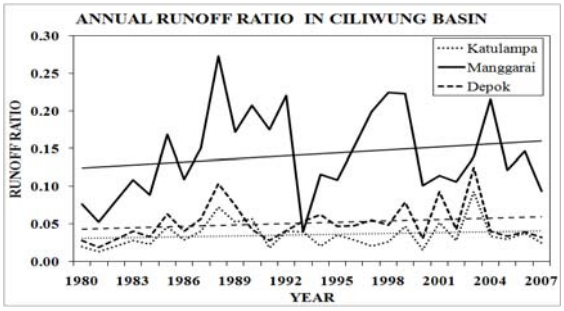


Fig. 3 Annual Runoff Ration in Ciliwung Basin

The left side of Fig. 4 shows the changes of land use (paved area) from 1990 to 2007. It is found that during the period of 10 years, from 1990 to 2000, the paved area increased from 27% (12,834 ha) to 40% (18,722 ha) of total Ciliwung Basin area (47,620 ha). Furthermore, by 2007, the paved area has increased rapidly to 92% of total basin area which means only 8% (3,338 ha) remaining open area in this basin. Right side of Fig. 4 shows the ratio of paved area in Ciliwung Basin in 1996, 2002 and 2007. To express the ratio of paved area in each sub-basin it is assumed that urbanization starts from the

downstream area to upstream area. The result shows that in 2007 almost whole area of downstream, Manggarai sub-basin, has been changed into paved area (0.9). As well as downstream, midstream and upstream area have also been changed into paved area, 0.8 and 0.7 respectively.

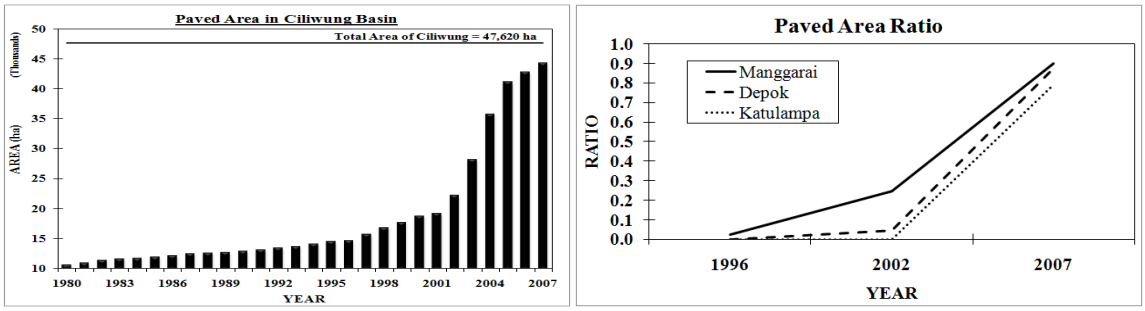


Fig. 4 Paved Area Changes and Paved Area Ratio in Ciliwung Basin

Land use change is a serious matter in Ciliwung Basin. The development of residential and business area has driven the farming and forest area in whole area of basin changed into paved area. The upstream areas, being the water absorbing areas, experienced a great deal of land use change, marked by a lot of constructions of housings. The change has enhanced the surface runoff instead of rain infiltration into the ground water as reflected in increasing of annual runoff ratio in Fig 3.

Water level data is the most important aspect to be considered in analyzing the potential effect of illegal residence to floods in this basin. Water level data can show the physical condition of river channel. The highest water level is in Manggarai Barrage. From 1996, 2002 and 2007, the water level in Manggarai Barrage is increasing from 970 cm, 1050 cm and 1061 cm. Meanwhile, either in Katulampa and Depok Weir, the water level in 2002 was lower than 1996, but in 2007 it showed considerable increase. From 1996 to 2007, the water level in each AWLR station has increased 16.8 cm in Katulampa, 56.9 cm in depok, and 91 cm in Manggarai. Accumulation of water from upstream and midstream together with narrowed river by illegal residences and also solid waste that piled up and clogged the gates in Manggarai Barrage may cause the water level in this section drastically higher than other barrage/weir.

The growth of floodplain occupation in Ciliwung Basin from 1983 to 2008 is fluctuating. In some years, like in 1996 and 2004, it is shown decreasing number due to river control works by local government. However these works are usually executed for short period of times, after that floodplain are fulfilled again by the illegal residences. In 2008 the Ciliwung floodplain area which are occupied by illegal residences reached 13.77 ha or 8% of total floodplain area. Moreover, about 9.317 ha of floodplain in Manggarai sub-basin is occupied.

Data Correlation

From Pearson Correlation calculation, land use and discharge have positive association, 13%. It means any changes of land use to paved area will affect to the changing of discharge.

Increase of occupied area in floodplain is associated with increase of water level. Pearson Method shown that the correlation between those data is 96.29 % associated. From this analysis, the flooplain occupation gives strong correlation to the increasing of water level in Manggarai Barrage. Floodplain occupation in Ciliwung River followed by other factors such as garbage accumulation, land subsidence,

sea tidal rising, etc, have given severe potential effect of flood in Ciliwung Basin, particularly in downstream area, Jakarta City. Thus the correlation result does not fully reflect the actual effect or relation between floodplain occupation and water level. The water level in Manggarai Barrage is not only influenced by illegal residence but probably by garbage accumulation in trash rack that installed in Manggarai Barrage. Therefore, for further investigation, the data of water level in upstream area of illegal residence and also the garbage volume and characteristic in the barrage are required.

Compound Channel Equation/Ida Method (Ida, 1960), briefly explained the correlation between floodplain area and water level. Ida explained that the peak discharge in one section of channel is equal to the accumulation of discharge in main channel (mc) with discharge in both sides of floodplain. The Ida's Method can be expressed as:

$$Q = 2\frac{A_{fp}}{n_{fp}}\left(\frac{A_{fp}}{S_{fp}}\right)^{2/3} \cdot {I_b}^{1/2} + \frac{A_{mc}}{n_{mc}}\left(\frac{A_{mc}}{S_{mc}}\right)^{2/3} \cdot {I_b}^{1/2}$$

Where: Q is discharge, A_{fp} is floodplain area, n_{fp} is floodplain roughness coefficient, S_{fp} is wetted perimeter floodplain, I_b is slope of bed channel, A_{mc} is main channel area, n_{mc} is main channel roughness coefficient, and S_{mc} is main channel wetted perimeter. Ida's equation can be derived as:

$$h_{fp} = \left[\frac{1}{2} \cdot \left(\frac{n_{fp} \cdot Q_t}{B_{fp} \cdot {I_b}^{1/2}} - \frac{n_{fp} \cdot B_{mc} \cdot {h_{mc}}^{5/3}}{B_{fp} \cdot n_{mc}}\right)\right]^{3/5}$$

By using the last formula, water level in floodplain (h_{fp}) can be identified. The water level changes will be explained by two different scenarios, by changing the floodplain width and by changing the roughness coefficient. There are some assuming parameters data, such as type of channel will be considered as lined or built-up channels. The wall made from concrete bottom float finished with sides of cement rubble masonry has roughness coefficient (n_{mc}) 0.03 in maximum condition. Floodplain is considered as the one with heavy timber, a few down trees, little undergrowth, flood stage below branches and its roughness coefficient (n_{fp}) is 0.120 in maximum condition. The slope of bed channel (I_b) is 0.01. Main channel depth (h_{mc}) is considered as 50 cm. Main channel width (B_{mc}) is assumed to be 30 m and floodplain width (B_{fp}) 15 m. The peak discharge is considered to be the one at Manggarai Barrage in 2002, namely 655 m^3/sec. From those scenarios can be identified that the changing of floodplain width by construct the concrete wall in the floodplain give big effect to the changing of water level in floodplain.

According to literature review from many sources, some problem of illegal resident relocation can be analyzed. The first matter is land price compensation. Illegal resident rejected to move from floodplain due to unequal compensation from the government so that they unable to construct a new housing in the new appropriate places. Other problem is rent fee system. Most of illegal residents who live in Ciliwung floodplain, particularly in Manggarai sub-basin, have no permanent jobs. Sometimes they have money but sometimes not. They cannot purchase or rent an appropriate house in a safe area. Further issues in management of apartment are human and healthy aspect and apartments facilities. The issue has been raised is one flat of apartment are allocated for two or three households. Considering humanity and healthy aspect, this situation is reprehensible. The basic facility such as electricity and clean water on the apartment becomes another problem that has arisen from the residents in apartment. Those facilities are not working properly.

CONCLUSIONS

1. The main cause of flood problem in Ciliwung River Basin is not because the increasing of rainfall.
2. The unusual phenomenon of decreasing rainfall and increasing discharge has indicated that land use in Ciliwung Basin has been changed significantly to the paved area that reduce the land infiltration.
3. From 1980 until 2007, land use in Ciliwung Basin has been changed significantly. The correlation analysis between the land use change into paved area and the increase of discharge gives 13% association. The paved area ratio has explained that the land use changed into paved area in whole sub-basin changed rapidly.
4. Water levels in the major flood events in 1996 to 2007 have been rising.
5. The correlation analysis of illegal residence to water level gives 96.29 % association.
6. From literatures review it can be concluded that the socio-economic problems of illegal relocation are the unequal compensation and the apartment management problems, such as the rental fee system and inadequate facilities. The recommendations for illegal residence relocation problem related to socio-economic efforts are law enforcement, periodic river control and monitoring, proper compensation, daily rental fee system, appropriate facilities installation.

ACKNOWLEDGEMENT

I would like to express my deep and sincere gratitude to Prof. Kuniyoshi Takeuchi, and Dr. Eng. Dinar Istiyanto for their detailed and constructive comments, important support throughout this work, and for their excellent advice during the preparation of this thesis.

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INNUNDATION ANALYSIS AND DEVELOPMENT OF RAINFALL RUNOFF MODEL FOR TINAU RIVER BASIN IN NEPAL

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ABSTRACT

Climatic change, unplanned land use pattern, deforestation, socio-economic change and human intervention are affecting the hydrology of Tinau river basin in Nepal. In the absence of proper flood management, extent of flood damages is increasing in every extreme flood events. The existing structural counter measures in this basin will not be sufficient against probable extreme floods. So, it is necessary to develop non structural counter measures. The methodology in this study is to develop non structural counter measures for downstream reach of Tinau river basin so that losses and damages due to flood disaster could be minimized with the simultaneous application of structural as well as non structural measures. This paper presents the results of inundation analysis and flood forecasting models based on Tinau river basin data. Inundation maps for different return periods will be provided to the community level so that communities can easily identify the depth of inundation of their place of interest. In order to develop the relationship between rainfall and runoff and hence to develop flood forecasting model, simple statistical tools for hydrological analysis and least square methods of best fit technique are applied with the available historical data. The developed model will be useful for community level people to prepare themselves during extreme flood events to save their lives and properties as a part of flood disaster management approach.

Keywords: Trend analysis, flood frequency analysis, inundation analysis, rainfall runoff modelling

INTRODUCTION

The main hazards repeatedly occurring and causing heavy losses in terms of lives and properties in Nepal are floods, landslides, avalanches, hailstorms, windstorms, lightning strikes, earthquakes, fire, and epidemics. The overall impacts caused by water-induced disasters such as floods, landslides, and avalanches are the most severe. Between 1983 and 2006, on average, 309 people

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were killed annually by the water-induced disasters. Every year heavy damages of infrastructure and property worth NRs. 1242 million (≈ USD 16 million) causing negative impacts on the social and economic development of the country (DWIDP, 1999). It is observed that majority of flood disaster victims are poor and marginal people. This trend of destruction due to floods will continue unless the reliable coping mechanisms are well established in advance. It is realized that non structure measures, including flood forecasting and early warning, are important and effective tools in flood management in Nepal (Osti et al., 2008). Identification of inundation depth in the flood zone and establishing a flood forecasting system would enhance the effectiveness of all other mitigation measures by providing time for appropriate actions. In this study, inundation depths are identified for different scenarios based on rainfall and discharge data in Tinau watershed.

STUDY AREA AND PROBLEMS

The Project area is located between 27^0 49' - 27^0 23' North Latitude to 83^0 36' - 83^0 15' East Longitude, the western part of Nepal and approximately 260 km west from the capital, Kathmandu. It covers parts of Palpa and Rupandehi districts. The Tinau River is originating from the lesser Himalaya Mountain range with a length of 103 km. Its width in the Terai plain ranges from 100 - 940 m. The Basin area of the Tinau River is 1081 km^2 in total, consisting of 669 km^2 of mountainous area and 412 km^2 of plain area.

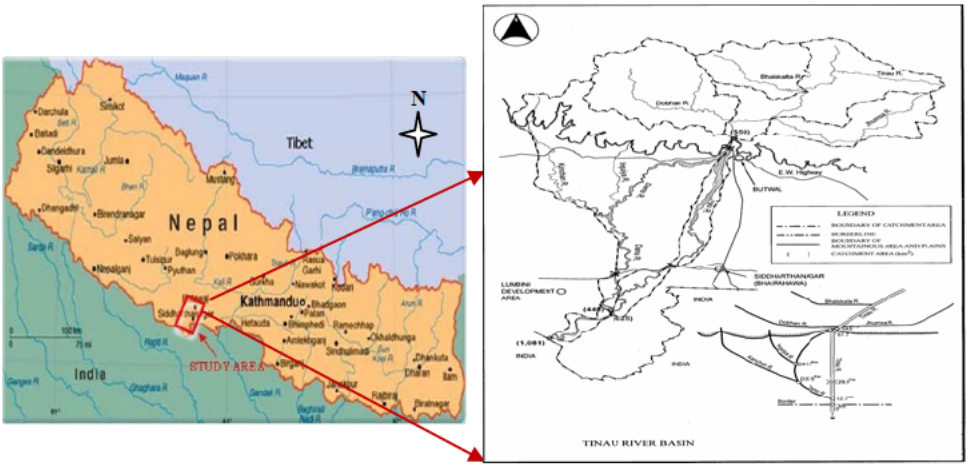


Figure 1 Map of Nepal and study area

Flooding is one of the major problems in this basin. Every year in the monsoon season, high floods in this river cause loss of lives and property. Major land erosion results in loss of agricultural lands in the middle reaches whereas the flooding in the lower reach causes inundation. The maximum 24 hour rainfall recorded was 320 mm in 1981. The most devastating floods occurred in 1970, 1979, 1981 and 1996. The flood of 1981 was more noticeable in magnitude and inundated area. In 1981, the flood swept away 70 lives, about 100 houses, irrigation intakes, agriculture lands along the river bank and also degraded a huge area of land due to sediment deposition. The cause of this flood was

a landslide, which blocked the river flow for several hours before it breached (Bhattarai, 2001). Dano River bifurcates from Tinau River near the foot of the hill and again joins Tinau River at about 13 km upstream from the Indian border. The risk of hazard is increasing inside the two river boundaries as a result of improperly development of infrastructures and poor drainage system. Poor and marginal people are living near the bifurcation point of the river and they are most vulnerable against extreme floods. At the point of convergence and inside the two river boundary, inundation occurs every year but the local communities don't know about areas and depths of inundation.

METHODOLOGY

Hydrological analysis

The rainfall and discharge data are analysed statistically in order to obtain the annual average rainfall, monsoon average rainfall, annual discharge, maximum discharge etc. Trend analysis provides an idea about climatic variability in the watershed. Trend analysis is done with linear regression test, Kendall's method and Student's **t** test to check the significance of trend. Floods for different recurrence intervals are calculated with Gumbel and Normal distribution. Chi-square goodness of fit is adopted for determining how well model fits the observed data. It allows us to evaluate how close the observed values are to those which would be expected. The objective of flood frequency analysis is to get the discharge for different recurrence intervals (Jayawardena, 2008). Natural dam breach case is also performed as the worst scenario.

Inundation analysis

The flood plain visualization is carried out using one dimensional hydrodynamic numerical model HEC-RAS. It is capable of performing water surface profile calculation for steady and unsteady flow conditions. HEC-GeoRAS, an ArcView extension, is used as the interface between HEC-RAS and ArcView GIS for pre-processing and post-processing for the data. The geometric data of the flood plain and river are obtained from the digital elevation model. Water surface profiles for floods of different scenarios are computed with subcritical flow simulation. These profiles are exported to ArcView GIS and water surface Triangular Irregular Network (TIN) is generated. Intersections of terrain TIN and water surface TIN result in an inundation map.

Rainfall runoff modelling

Statistical method, the best fit technique, and least square methods of error minimization are chosen to set up the model based on available data sets.

RESULTS AND DISCISSIONS

Average annual and monsoon precipitation (June-September) in Tinau watershed are 1985 mm and 1637 mm respectively. Monsoon rainfall is 82.26% of annual rainfall. Average annual rainfall of Nepal is 1700 mm and 75-85% of rain falls in the monsoon period. Observed average annual rainfall data is analyzed by linear regression. The slope of the trend line '*b*' is 2.20 positive. The

result of Kendall's coefficient (τ) is 0.011 positive. Significance test for average annual rainfall is performed with student's **t** test and it is found that there is no significant trend at 95% confidence level (α = 0.05).

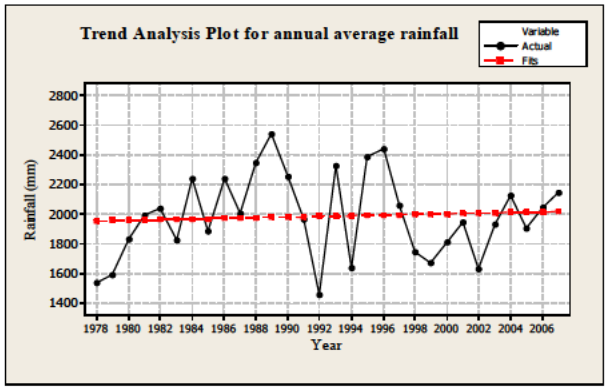


Figure 2 Annual average rainfall trend

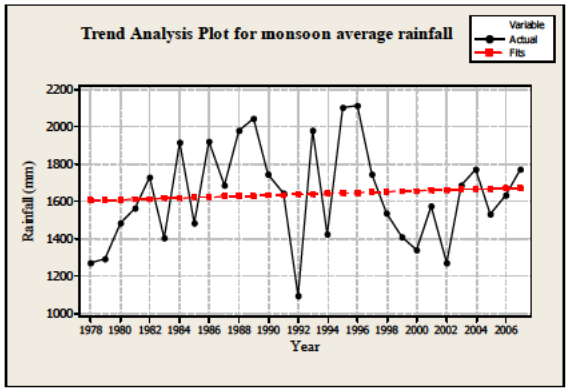
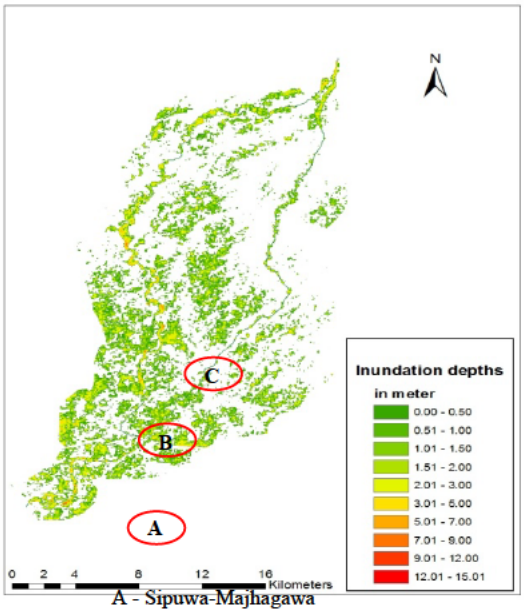


Figure 3 Monsoon average rainfall trend

To find the chi-square (χ^2) value for the estimated frequencies of different flood events with an application of Gumbel and Normal distribution, the return period for particular value of plotting position discharge were calculated. Chi-Square at (9 - 1) = 8 degree of freedom (n-1, degree of freedom for error) at probability level P = 0.05 is 15.5. Since both the calculated Chi-Square values are less than the values at P = 0.05, Null hypothesis (Fit of distribution with the Gumbel and Normal distribution) is not rejected. Gumbel distribution is best fitted for the observed data and discharges for different return periods are calculated as in Table 1.

Simulated inundation depth of 1996 flood (Fig. 4) shows many of the areas inside the two river boundaries are inundated. The depth of inundation is more in the downstream area compared to upstream area. The mean depth of inundation is 1.05 m during 1996 flood.

Natural dam breach analysis is simulated for a 20 m high dam. It is assumed that the natural dam will fail by overtopping and collapse fully within 0.3 hours. Obtained hydrograph is used for unsteady flow inundation analysis. The peak flow of dam breach



A - Sipuwa-Majhagawa
B - Kamahariya
C - Amuwa-Dayanagar

Figure 4 Inundation map of 1996 flood

hydrograph is 9260 m^3/s. Inundation analysis result shows that Bhairahawa city will be inundated up to 3.08 m in case of dam breach.To protect the Bhairahawa city, height of levee required is 3 m in case of usual flood scenario and 5 m in case of natural dam failure.

Table1 Flood discharges for different return period

Return period (Tr) yr	2	4	10	20	50	1996 flood	100	200	500
Discharge (m^3/s)	659	1053	1503	1826	1928	2485	2556	2868	3280

Inundation depth for different scenarios are identified at three points (Sipuwa-Majhagawa, Kamahariya and Amuwa-Dayanagar) and plotted between flood magnitude (log Q) and average inundation depth. In the plotting graphs, logarithmic curve is best fitted. Fitted curve has good average coefficient of regression, $R^2 = 0.943$ (excluding dam breach) and $R^2 = 0.971$ (including dam breach). Figure 5 is an example of plot between discharge and average inundation depth at Kamahariya. With this plot, local community people can easily identify the inundation depth for corresponding forecasted discharge.

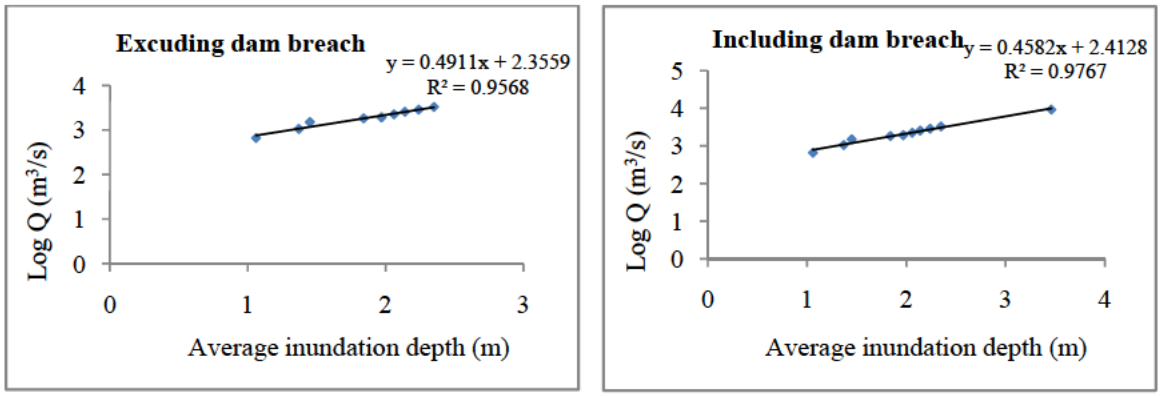


Figure 5 Plot of discharge Vs average inundation depths at Kamahariya

The rainfall runoff modelling is done for different cases and it is found that the best result is the one considering last 24 hours observed rainfall and the discharge in the river in previous 24 hours.

$Q_p = K_1 * Q_{t-1} + K_2 * B_t + K_3 * T_t$

Where,

Qp = discharge at forecasting time t in m^3/s

Qt-1 = observed discharge at time (t-1) in m^3/s, i.e. previous day

Bt = observed rainfall at station Butwal in *mm* during last 24 hours

Tt = observed rainfall at station Tansen in *mm* during last 24 hours

Table 2 Model coefficients and errors of model (calibration - validation)

Model coefficients			Calibration (1984-2002)			Validation (2003-2007)		
K_1	K_2	K_3	R^2	MAE	RRMSE	R^2	MAE	RRMSE
0.208	5.933	5.403	0.95	7.52	0.1762	0.94	5.97	0.1430

This model is best fitted for the Tinau river basin based on available hydrological data. Using this model as flood forecasting and early warning could save the life and property to some extent at lower watershed of Tinau River. This model is simple one and using this model even the community level people can forecast the probable flood. Every day the rainfall on Butwal and Tansen rain gauge stations is forecasted by communication media. So, next 24 hours expected rainfall of that region is known. If the community level people get information about the discharge in the previous day at Butwal station, knowing all the parameters and coefficients, the probable flood could be easily forecasted.

CONCLUSIONS

The study area has suffered from various types of hydrological disasters, and flood is one of the major. Inundation analysis and flood forecasting is a very useful tool for flood risk management for Tinau river basin. Decision makers and communities are often concerned with extend of inundation areas and flood depths at specific locations. Flood maps were prepared for various return periods and corresponding inundation areas and depths were computed. Once the probable discharge is predicted, with an application of rainfall runoff model, community people can identify the inundation areas and depths from discharge inundation depth relationship. Once the depth of inundation is identified, they can make evacuation plan to save their lives and properties against coming flood in time. The inundation maps can be used as flood forecasting, awareness raising, development planning, emergency services and post disaster rehabilitation aimed at reducing flood damages and economic impacts in future. As this model is based on 24 hours observed data, it will be updated with hourly observed precipitation data in future.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Prof. A. W. Jayawardena and Dr. Rabindra Osti of International Centre for Water Hazard and Risk Management (ICHARM) for their advice, constructive comments and showing right path of my work from the inception to the completion of my thesis.

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参考資料 6-1　自由回答結果一覧

April, 2009

Result of Interim Course Evaluation

ICHARM

Q-1 Please describe the good/bad points regarding to the following subjects. (including practice) .

(1) Basic Hydrology, Advanced Hydrology (including practice)

- **Practical** oriented
- **Diverse issues** have been covered
- Helpful in **professional life for analyzing problems and finding solution**
- I learned about basic concept of hydrology and advance hydrology. It is very helpful and interesting. Theory behind modeling and forecasting were focused clearly.
- There were lot of new ideas and new calculation methods that I had never heard of. I enjoyed the lectures very much.
- This course is very useful for hydrology engineers and it is the basic knowledge we should obtain and then use it in our further works.
- I have found the aforementioned courses are very important and basic for the program we are attending.
- I learned about basic concept of hydrology and advance hydrology. Now I can able to prepare hydrograph and also to forecast rainfall or discharge of catchment.
- With learn Basic and Advanced Hydrology, now I know about forecasting and how to calculate and draw hydrograph.
- Good, it's the basic concept of hydrology

(2) Hydraulics (including practice)

- New idea has been discussed
- Important for look the problems in different angle
- Wide coverage **but little practice**
- **More practice** may be helpful
- The lectures were very useful for river engineering. **Content should be extended up to advanced hydraulics**.
- It is not an easy lecture. We learned how to deal with practical hydraulic problems with hydraulic equations.
- This course is also very useful for hydrology engineers. **I think the courses are too less, it should be added more lectures.**
- The subject by itself is important and mandatory for the program
- The lectures are very useful for river engineers but **due to lack of time, Professor delivered more ideas in sort duration**.
- This lecture is very important in river engineering. But **this lecture is too short. It is need to allocate more time to this lecture**.
- Good, it's the basic concept of hydraulics

(3) Basic Concepts of Integrated Flood Risk management (IFRM)

- Excellent course of looking the problems in social point of view
- Helpful for managers in decision making
- **Practice with real problems** can be helpful for generating new ideas
- Idea and concept delivered by professor were very clear and easy to understand. It will help me to think logically for decision making of integrated watershed management.
- It is a very important lecture for me. I formed new ideas to consider disasters with vulnerability analysis. This idea is surely very helpful to me.
- We learn some advanced knowledge on this filed, it is very good.
- The contents are well prepared and organized. Therefore, I recommend it to continue as it is.
- Idea and concept delivered by professor are very clear and it will help me to think logically during Integrated watershed management.
- Many concepts learn in this lecture due to risk and vulnerable of community from disaster.
- Good, it's the application of all subjects

(4) Local Disaster Management and Hazard Mapping

- Good for the professional for making decision
- **More emphasis can be given on GIS practice**
- **Little theoretical background of used model has been discussed**
- Important, helpful and interesting. **Minimizing Japanese experience and including other country's experience may improve** this course.
- This lecture is practically useful in disaster mitigation.
- **There are too less time for us the do the practical work**. It should be longer.
- It is very crucial part in flood disaster mitigation program.
- It will help me to manage the flood risk at the community level as non structural countermeasures like flood hazard map, early warning system etc.
- Hazard Map is very important to the peoples who have vulnerability from disaster and how to make and implement a disaster management to the community. This lecture was presented so well.
- Good, it's the application of all subjects

(5) Flood Hydraulics and Sediment Transport (including practice)

- Good course with wide discussion on Japanese research in this field
- **Emphasis on the research of all around the world can be helpful**
- I learned about the phenomena of sediment transport. **River mechanics should be emphasized**. It needs more practice in the class.
- There are many new ideas such as hydraulic characteristics of the flood flow and temporal water surface profiles. They are important and useful in river management.
- **Just some introductions and concepts, no details**
- Very important and crucial subject in flood disaster mitigation program
- I learned about the phenomena of sediment transport. How the sediment can be controlled in upstream of the river. **It needs more practice in the class**.
- In disaster program we really should learn this lecture. This is the point of disaster course related to river/water.

(6) Sustainable Reservoir Development & Management (including practice)

- Wide topics has been discussed
- Practice on some issues like sediment management, temperature and density stratification can be helpful for the student.
- Lectures were important but **overall management was focused than construction management.** Trapezoidal RCD CSG method was helpful for construction cost minimization.
- Dam design is a part of my major in university. In this lecture, I learned a lot about the reservoir development and management in Japan. That's a good experience.
- **Just some instructions, no details**
- It is very important to develop good knowledge about dam its importance
- Lectures are important but **I am not able to get the concept clearly.**
- Now a day, we need to think about water conservation. With this lecture we know how to manage water sustainable.
- Good, I have learned something about dam

(7) Computer Programming

- Excellent useful course
- **More practice on real problem will be helpful**
- I learned about basic concept of FORTRAN Language. **It needs more practice.**
- I was familiar with VB and C#. In this lecture, I learned Fortran and I can use it to deal with some problems.
- I think **this course should not only limited in FORTRAN, how about VB or other languages**?
- **Better to focus on practical application**
- I learned about basic concept of FORTRAN Language. **It needs more practice**.
- We need computer programming to solve many problems in our specific works.
- Good, it's useful for making our own model

(8) Practice on Inundation Analysis

- Useful course
- **Theoretical background of used model should be discussed in details**
- We used special package of HEC-Ras for Inundation analysis. **Theory behind the HEC-Ras model should also be explained clearly.**
- Inundation analysis is very important for flood hazard mapping. It is a really useful technology.
- It is wonderful,
- Very important subject for the program we have studied and the contents are also well prepared.
- We used special package of HEC-Ras for Inundation analysis. **But we did not learned in detail about the governing equations** on which it works.
- This lecture is also helpful in my job. To mitigate from flood, we need to analyze inundation. **It is important to put more time in this lecture.**
- Good, we need it in the individual study

(9) Practice on Hazard Mapping

- **Basis of hazard mapping all around in compare to Japan the world can be discussed**.
- The result depends upon the DEM data. **High quality DEM data was not available**.
- Flood hazard mapping is very useful in every country. I am familiar with how to make it now.
- It is very useful; we got some experiences in the field trip
- Important to understand well about hazard mapping
- The result depends upon the precise DEM data. **Sometimes it is very difficult to find out the exact shape of small rivers (flashy rivers) on SRTM data**.
- Just like Inundation Analysis, this lecture also important. **It is better to put more time too**.

(10) Practice on River Training

- Useful course
- **More practice on real problems** is required
- We went for study trip and learned about the actual problem in the site and appropriate countermeasures against it. High and advanced technologies for river training were focused rather than low cost appropriate technology.
- I learned about how to solve practical problem with theories.
- The practice is useful
- **Good but needs to carry out more exercises**
- We went for study trip and learned about the actual problem in the site and appropriate countermeasures against it. It is very helpful to increase our practical knowledge.
- Almost all the problem in water engineering is talk about river and also the recurrent disaster related to water is come from river problem. This lecture is important

Q-5. If you have any requests and comments for the course, please give us your opinions freely.

- Overall, it is a nice course. I think **more assignment related to the practical problem can be given** to the student to solve by themselves will further improve the course.
- Low cost appropriate technology for flood management which is most fruitful for developing countries during flood were quite neglected.
- **Number of Professors are too short to mention**.
- **At the beginning, too many ideas to grasp in very short time. It should be uniformly distributed up to end of March**.
- Report writing and Presentation techniques should be conducted.
- I'm glad to have taken part in the course. Thank you!
- I think **there must be some textbooks** prepared for us; and the schedule be ranged more reasonably.
- **Sometimes we got a lot of assignments and examinations in one week**.
- In developing country like Nepal, there is no special unit for research and design. Civil engineers (field engineers) have to do both design and implementation. If our topics and lectures are practical oriented then it is more useful for us.
- The lectures given by **Prof. Fukuoka are based on compound channel. If he will give an idea about ordinary channel will be more useful**.
- Time schedules are too tight and so many things to do in short time.
- Some of the lecturers are not from teaching background, so they can't explain so good and too fast. Better to hire teacher from the other university.
- Almost all the lecturers from outside ICHARM can't speak English fluently. Although we also can't speak English fluently, at least our passive English is good. How can we understand the lecture if the lecturer can't deliver the lecture with good English?