



# *Certificate of Appreciation*

Presented to :

**Bambang Istijono**

**in Recognition of Outstanding Contribution as Presenter**

International Symposium of

The 82<sup>nd</sup> Annual Meeting of

International Commission on Large Dams (ICOLD)

2 – 6 June 2014

Bali Nusa Dua Convention Center, Bali – Indonesia

Bali, 4 June 2014

A handwritten signature in black ink, appearing to read 'M. Basuki Hadimuljono'.

Dr. M. Basuki Hadimuljono

Chairman of INACOLD

# Invitation from Chairman of Organizing Committee and President of INACOLD

Dear ICOLD Members,

On behalf of The Indonesian National Committee on Large Dams (INACOLD). I would like to extend our invitation to participate in the 82nd Annual Meeting of ICOLD. The event will take place in Bali on 2-6 June 2014 at Bali Nusa Dua Convention Center (BNDCC).

Along with the history of ICOLD, Indonesia has been recorded as member country of this world prestigious organization. For Indonesia, this is the second time we have been entrusted to host such an important event of ICOLD. The first one was in Jakarta in 1986. I believe that through this important event, we will be able to show you the whole set of our experience in implementing the country's development and management in large dams in particular and in the water resources development in general.

The selection of Bali as the venue of the meeting is not just because of its reputation as a tourist destination, but more than that, it has proven record of hosting various kinds of international events. It is also an opportunity to see boundless variety of unique sceneries as well as countless traditional and cultural heritages.

Our Social programs are designed to provide you with unique opportunities to taste and feel the best of Bali's hospitality and its unique culture, through various exciting and full-filled activities held before, during and after the event. To complement these, the distinct culturally rich province offers an extensive range of hotels, exquisite cuisines, fascinating sceneries, a genuinely friendly and charming people practicing an authentic ancient heritage culture and almost unlimited recreational and cultural options.

We trust that the time you spend with us in Bali will be most rewarding, which leads to many experience and friendships. We are looking forward to welcoming you to the 82<sup>nd</sup> Annual Meeting of ICOLD and hope that your participation will be productive as well as memorable.

**Dr. M. Basuki Hadimuljono**

Chairman of INACOLD



## Preface

The International Symposium, with the main theme on DAMS IN GLOBAL ENVIRONMENTAL CHALLENGES, conducted in 4<sup>th</sup> June 2014, is one among the events in the 82<sup>nd</sup> Annual Meeting of the International Commission on Large Dams in Bali, Indonesia. It is a great honour to have all ICOLD delegates and dam experts, professional managers, as well as decision makers from the international dam community to participate in the international symposium. The objective of the symposium is to collect the knowledge of the latest development from the dam experts from various field of expertise to share with dam engineers in developed and developing countries, and to transfer especially to young dam engineers to ensure the dam engineering sustainability.

The topics in the international symposium are listed as follows:

1. Social and environmental aspects of dam,
2. Engineering issues in dam development,
3. Challenging in tailing dam project,
4. Dams and water quality management,
5. Catchment area management for sustainable dam development,
6. Challenges in dam safety policy and implementation,
7. Dam operation in connection with climate change.

We have received 532 papers from 53 countries related to the theme and the topics. These papers were evaluated by national reviewer as well as international reviewer, involving experts related to dam engineering and environment from various countries. The result is that 246 high quality papers, of which 146 papers are presented in oral session and 81 papers presented on poster session.

We also provide awards for the best paper and presenter among young engineers to encourage their further involvement in the dam engineering, development, and management. We hope, the presentations and discussions are fruitful, and further provide contribution to the future sustainable dam engineering.

### **Bambang Hargono**

Chairman of the Symposium and Workshop Committee,  
The 82<sup>nd</sup> Annual Meeting of ICOLD, 2014, Bali.



# Organization of the Symposium

**Chairman,** Bambang Hargono  
Eddy A. Djadjadiredja  
Widagdo  
Tri Bayu Aji

**Secretariat,**  
Ade Karma  
Wida Firliyan Tirtani  
Rudi Resmiyadi  
Deni  
Feby Choirul Humawardani

**Reviewer,**  
Prof. R. W. Triweko  
Prof. Iwan K. Hadihardaja  
Prof. Hidayat Pawitan  
Prof. Indratmo Soekarno  
Prof. Nadjadji Anwar  
Prof. (R). Simon S. Brahmana  
Prof. (R). Robert Delinom  
Dr. Arie Setiadi Moerwanto  
Dr. F. Mulyantari  
Dr. William Putuhena  
Dr. M. Yanuar J. Purwanto  
Dr. Aries Firman  
Dr. Mochammad Amron  
Dr. Barti Setiani Muntalif  
Eddy A. Djadjadiredja  
HM. Soedibyo  
Bhre Susantini R.  
Bambang Koeswidodo  
Moegijantoro  
Zainudin  
Widagdo  
Sri Hetty Susantin  
Husni Sabar  
Rismatoyo

**International Reviewer,**  
Stephen Fox (Australia)  
C.B. Viotti (Brazil)  
Anton J. Schleiss (Swiss)  
Xu, Ze Ping (China)  
Jian, Ping Zhou (China)  
V.K. Kanjlia (India)  
Tadahiko Sakamoto (Japan)  
Kyung- Soo Jun (Korea)  
Paul Roberts (South Africa)  
Pham Hong Giang (Vietnam)  
Ali Noorzad (Iran)

# Table of Contents

Invitation from Chairman of Organizing Committee and President of INACOLD	i
Preface	ii
Organization of Symposium	iii
Table of contents	iv
<b>Sub Theme 1: Social and environmental aspects of dam</b>	
Study of Social and Economic Impacts of Construction of SIAHBISHEH Dam Using Rapid Matrix Method <i>Rooollah Mohammadvali Samani, KazemHeidarpourChenar, FatemehIravaniniayTehrani</i>	I-1
The Evolving History of Lake Biwa Weir <i>Masahisa Nakamura, KatsukiMatsuno</i>	I-11
Environmentally friendly water-powered DTH drilling in dam applications The history of Down-The-Hole-Drilling and use of water-powered hammers <i>Donald A. Bruce, Rudy Lyon, Stefan Swartling, Michael Beas</i>	I-21
Development of Cruising RCD Construction Method <i>Y. Yamaguchi, T. Fujisawa&amp;Y.Yoshida, T. Sasaki</i>	I-32
Public participation, Human Security and Public Safety around Dams in Sweden: A case study of the regulated Ume and Lule Rivers <i>M-B Öhman, M. Palo, E-L Thunqvist</i>	I-42
Roadmap of pre-investment process for a hydropower project. Case study Tarnita-Lapustestipumpstorage hydropower plant. <i>Irinel Daniela Jacob</i>	I-52
Evaluation on the Effect of Dam Engineering to Atmospheric Ecosystem <i>LinzhangGao, Fuhai Yao &amp; Bin Duan</i>	I-61
Environmental Management During Construction inCompliance With Mexican Regulations <i>M.A. Gomez-Balandra, C. LecandaTerán, A. Hollands Torres and R.D. LlerandiJuárez</i>	I-66
Greenhouse Methane Gas Emission From Reservoirs In Java, Indonesia <i>Simon S.Brahmana, Tontowi, Sukmawati, Yani Sumariani</i>	I-76
European Working Group "Management of dam incidents" Case study: Finland <i>Juha Laasonen</i>	I-86
La Romaine Hydroelectric Complex - Management of the Riparian flow at Romaine 2 during construction and reservoir filling <i>Jean-Pierre Tournier, Luc Roy, Redha Kara, Isabelle Thériault</i>	I-92
Technical, Socio-Economic and Environmental aspects in converting Devsari H.E.P. (252MW) from Storage to Run of the River Scheme <i>Deepak Nakhasi&amp; Harsh Bhaskar Mehta</i>	I-102
Implementation of the Hydropower Sustainability Assessment Protocol: Romanche-Gavet's project under construction in France <i>Emmanuel Branche</i>	I-113
Silvan Project Implementation by Participation and Impacts on the Society, Economy and Environment <i>ÖnderÖzen, ErgünÜzücek, TuncerDinçergök</i>	I-122
Study on environment friendly hydropower project construction <i>Xu Zeping</i>	I-133
Integrated Water Resource Planning For South Africa: Water Use Efficien <i>T. Nditwani</i>	I-143
Public Safety Around The Dams In Slovenia <i>Nina Humar, Andrej Kryžanowski</i>	I-152

Management At Downstream Of Ir. H. Djuanda Dam With Public Participati On <i>Djuanda, H. Rachmadyanto, L. Agustini</i>	I-162
Enhancing Community Participation In Dam Management (Prepairing Emergency Action Plan) Using Visual Communication Media Concept (Case Study : Krisak Dam, Wonogiri, Central Java, Indonesia) <i>Juliastuti, Sari Wulandari</i>	I-171
Landslide Prevention On Reservoir of Upper Cisokan Pumped Storage Hydropower Based on Community Development <i>Buchari Zainal Arifin, Nurmala Fauzia</i>	I-182
Strategies of public awareness on dams and reservoirs <i>J. Polimón</i>	I-189
Multi-Criteria Studies for the Sustainable Management of Excavation Waste from three major Pumped Storage Power Plants Projects in Spain. <i>V. Mendiola, M.E. Polanco &amp; A. Zamo</i>	I-196
Blasting Vibration Control in Residential Area near Cheragh–Vays Dam <i>Amir Hafezquran</i>	I-206
A survey about passive defense, and lake dam's requirements to water fronts and how to construct a floating waterfronts in accordance with changes in Water levels in dams <i>Meysam Rezaei Ahvanouei, Hamid Ehsani, Mahyar Rezaei Ahvanouei</i>	I-216
The Karalloe Multipurpose Dam For Environmental And Raw Water Development <i>Agus Setiawan, Hariyono Utomo, Eka Rahendra, Subandi, Andika Kuswidyawan, Arif Paputungan</i>	I-222
The Saddang Multipurpose Dam For Anticipate Flooding And Environmental Development <i>Sumardji, EkaRahendra, Subandi, Andi M. Irham, M. K. Nizam Lembah, Sukarman</i>	I-232
Environmental Management On The Pre-Construction Stage Of Ucps Hepp Development <i>Tona Indora, Arief Heryana, Akbar Nugroho</i>	I-242
<b>Sub Theme 2: Engineering issues in dam development</b>	
Estimation of interfacial properties of concrete face and seismic analysis on the highest concrete-faced rock fill dam in South Korea <i>G.C. Cho, K.I. Song, H.J. Yun</i>	II-1
Underground dam construction as delayed efforts to enrichment roundwater in arid areas of Bunutan, North East Bali, Indonesia <i>Anwar Makmur, F. Mulyantari</i>	II-11
Impact Drilling in Embankment dams – A Comparative study between Water-powered DTH HammerDrilling Technology and Hydraulic Top Hammer Drills <i>JörgRiechers, Michael Beas</i>	II-21
The importance of redundancy in the surveillance of aging dams – the CahoraBassa experience <i>Ilídio Tembe, Ezequiel Carvalho, Louis Hattingh</i>	II-31
Dam Svartevatn An example of challenging upgrading of a large rockfill dam <i>P. H. Hiller, L. Lia, P. M. Johansen, R. Guddal</i>	II-40
Dynamic Analysis of Seismic Behavior of Raised Concrete Gravity Dam During Large Earthquake <i>Masafumi Kondo, Takayuki Shida, Yasufumi Enomura, Takashi Sasaki</i>	II-50
Seismic analysis of concrete gravity dam installing new outlet works conduit into existing dam body <i>Takayuki Shida, Masafumi Kondo, Takashi Sasaki, Yasufumi Enomura</i>	II-60
Technical Issues on Detailed Design of RCC dam for the Dasu Hydropower <i>J. Fukuwatari, I. Araki, M. Iijima, H.M. Farooq Ahmed</i>	II-70

Effects of limited number of slip circles and arbitrary slip circles on sliding deformation of embankment dams due to earthquakes <i>Sho Fujikawa, Hiroyuki Sato &amp; Yasufumi Enomura</i>	II-80
Cracking on embankment dam body due to recent large earthquakes and direct and splitting ensile strength tests for earth-core material <i>Hiroyuki Sato, Yasufumi Enomura, Y. Yamaguchi</i>	II-90
Effects of reservoir water level and temperature on vibration characteristics of concrete gravity dam <i>Takeshi Kashima, Takashi Sasaki, Masafumi Kondo, Yasufumi Enomura</i>	II-100
Evaluation of Embankment Material Properties Affected by Circular Slip Failure Mode due to a Large-Scale Earthquake <i>Tomohiro Shiono, Akira Takahashi, Kazunori Takasawa, Tomokazu Suzuki</i>	II-110
Capacity of Passive Rock Bolts in Concrete Dams – Improved Design Criteria <i>C. Thomas-Lepine, L. Lia</i>	II-120
Effects of Rock Mass Anisotropy on Deformations and Stresses around Tunnels during Excavation <i>T.D.Y.F. Simanjuntak, M. Marencé, A.E. Mynett, A.J. Schleiss</i>	II-129
Filter Design for Wet Core Embankment Dams in Wet Climates <i>Abbas Soroush, Sina Shams Molavi MSc, Piltan Tabatabaie Shourijeh</i>	II-137
Prediction of Crest Settlement of Concrete-Faced Rockfill Dams Using a New Approach <i>A. Noorzad, D. Behnia, S.R. Moeinossadat, K. Ahangari</i>	II-147
Design And Construction Challenges Of The Canal Borinquen Dams 1w, 2w, And 2e <i>Winnie Kim, Carlos Zambrano, Chris Ottsen, Donald J. Montgomery</i>	II-156
Evaluation of Flow Characteristics and Cavitation at Chute Channel Using Hec-Ras Model (Case Study : Germe Chay Spillway Chute Channel) <i>Sh. Partovi Azhar, A. Mihandoost</i>	II-166
Laboratory and Numerical Study on Design Parameters of Earth Pressure Cell <i>A. Noorzad, K. Ahangari, M. Golestanifar</i>	II-174
Upgrading Sant Llorenç Dam's Gates <i>Felipe Río Iglesias, Francisco José Conesa Baños, Antonio Palau Ybars</i>	II-184
Flood in June 2013 and Dams Example of flood routing through Hostivar reservoir <i>J. Riha</i>	II-194
Strengthening of the Right Abutment at a Norwegian Arch Dam <i>Lunde, M., Halvorsen, A., Strokkenes, S. A, Panthi, K. K., Lia, L.</i>	II-202
The construction of "Digital Dam" System <i>Fan Qixiang, Zhou Shaowu, Wu Kun</i>	II-211
Assessing Hydraulic Fracturing of Rockfill Dams using Laboratory Tests and Numerical Analysis <i>D. Djarwadi., K.B. Suryolelono., B. Suhendro., H.C. Hardiyatmo</i>	II-218
Finite Element Modeling For Acoustic Reservoir-Dam-Foundation Coupled System <i>Bakenaz A. Zeidan</i>	II-228
Vibration model tests on the seismic characteristics of raised fill dams <i>Hidekazu TAGASHIRA, Yoichi HAYASHIDA, Seiichiro KURODA And Susumu MASUKAWA</i>	II-241
Evaluating the Drainage Condition on Seismic Behavior of Dam <i>Nima Tavakoli Shirazi, Mahdi Azhdary Moghadam</i>	II-251
Application Of Simple Hydrologic Model For Recalculating Water Balance Of Cacaban Dam Irrigation System <i>Sukirno, Sahid Susanto</i>	II-260

Reviewing necessity of consolidation grouting in Foundation of Roudbar Lorestan Earth core Rock Fill Dam <i>Ali Azin</i>	II-267
Lessons learned and experiences from treatment works on hydraulic structure Karolínka <i>E. Bednárová, D. Grambličková, J. Babečka, P. Glaus</i>	II-273
Comparative Similarity Study on Hydraulic Losses of a Y-bifurcation <i>U. Lasminto, R. Klasinc</i>	II-282
Non Linear Seismic Analyses of Dams:New methods <i>M. Meghella, L. Furgani</i>	II-292
Prospects Of Rehabilitation Of The Vogršček Dam – A Self Sufficient System <i>Andrej Kryžanowski, Ester Džamastagič, Nina Humar</i>	II-301
The Use Of Geophysical Method Gpr - Ground Penetration Radar In The Quality Assessment Of The Embankment Dam <i>C. H. de A. C. Medeiros</i>	II-311
Issues on small dam development and management in Korea <i>Wook Jong Ju, Jeon Young Ryu</i>	II-319
Pre Elementary Evaluation Of Obel-Obel Underground Dam <i>Ahmad Taufiq, Deasy Rosliani, Edwin Ruswandi</i>	II-327
Leakage Evaluation from Foundation of Old Embankment Dam by Instrumentation Data Analysis and Geoelectric Field Tests: A Case Study on Mahabad Dam <i>F. Jafarzadeh, S. Yoosefi, M. Banikheir, H. Ghasemzadeh, A. Akbari</i>	II-342
Analysis of Longitudinal and Transverse Cracks in Crest of Doroodzan Earth Dam and Left Abutment Leakage <i>F. Jafarzadeh, S. Yoosefi</i>	II-352
The Safety Criteria for Geotechnical Instruments on the Internal Erosion in Embankment Dams <i>Chinoros Thongthamchart, P. Brohmsubha</i>	II-362
Xayaburi Hydroelectric Power Project Status report of the implementation of this large Kaplan project <i>Bernhard Muehlbachler</i>	II-372
An Example of Small Hydropower development in Italy <i>S. Citterio</i>	II-382
Reliability of conjugation of concrete and rock-fill dams of the Boguchany HPP <i>A. N. Volynchikov, Yu.B. Mgalobelov, I.V. Baklykov</i>	II-390
Engineering Issues In Dam Development Management Of Aging Dams <i>Bijan Farhangi</i>	II-400
A Study on a Field Application about Concrete Face Surface Inspection of C.F.R.D(Concrete Faced Rock-fill Dam) Using the Impact Echo <i>Chang-Gun/Shin, Minlee/Chae, Wang-gon/Lee, Young-Jung/Kim</i>	II-409
Adding extra spillway discharge capacity, a few dam refurbishment examples <i>James Yang, Romanas Ascila, Carl-Oscar Nilsson</i>	II-421
Feasibility Analysis for Construction of New Dams in Rajasthan State <i>Mathur Pradeep, Gupta N.K., Jethoo A.S.</i>	II-431
Determination of Rock-fill Parameters Based on a Hardening Soil Model Using Large Scale Triaxial Test results <i>A. Akhtarpour, M. Salari</i>	II-441
Relation between Engineering Properties from Laboratory Testing of Embankment fill Material and Geophysics Investigation are Use for Real-time Dam Safety Assessment for Large Dam in Northern Region of Thailand	II-450



Dam Development in Landslide and debris flow disaster area in Mae-Ngon Basin, Fang District, Chiangmai Province, Thailand <i>Chatchai Pedugsorn</i>	II-459
Instrumentation for Aging Dam in Northern Region of Thailand for First Case Study of Mae-Jok-Luang Dam, Chiangmai Province, Make Changes in Dam Safety Management Policy and New Concept of Dam Instrumentation for Aging dams of RID (Royal Irrigation Department). <i>Chatchai Pedugsorn</i>	II-469
Rational allocation of funds for upgrading aging dams <i>I. Asman, C. Tudorache, D. Stematiu</i>	II-479
A Practical Consideration on the Damage to Old and Small Irrigation Dams by the 2011 Tohoku Earthquake <i>Kazumi Ueda, Masakazu Matsura</i>	II-489
Prediction of Concrete Frost Damage of The Nagawado Dam Based on The Standardized Freezing and Thawing Cycle Method <i>Reina Doi, Takahide Kurose, Hiroaki Noguchi</i>	II-499
Attenuation Relationship of Earthquake Motion at Dam Foundation in Consideration of The 2011 Tohoku Earthquake <i>Takeshi Ito, Takashi Sasaki, Y. Yamaguchi, T. Annaka</i>	II-509
Trends of annual behavior of concrete dams <i>Mikio NONAKA, Takayuki SANO, Koichiro OTAGAKI And N. Shirakawa</i>	II-519
Underground Dam as a technical solution for a social problem Securing scarce water resources against mine activities Case study: Ali-Abad copper mine - central Iran <i>Vafa Kamalian, Mohammad Ahmadi, Hamid Reza Seif, Kourosh Shakeri</i>	II-529
3D Numerical Study of the Efficiency of the Grouting Curtain in an Embankment Dam <i>A. Akhtarpour, M. Damghani</i>	II-539
Determination of Critical Submergence at Intakes Using a CFD Models ( Case Study Aydoghmush Dam's Intake System) <i>Sh. Partovi Azhar, D. Farsadzadeh</i>	II-549
During Construction Behavior of Ghermi Chay Dam <i>S. Ghorbany, M. AkbarzadGhamari, A. Mihandoost</i>	II-559
Estimation of Water Balance for Maninjau Hydropower in West Sumatera using TRMM and Discharge Data <i>Bambang Istijono, Revalin Herdianto, Dalrino, Adek Rizaldi</i>	II-568
Multiple Water-Tightening Systems in the Foundation of Upper Gotvand Dam, Southern Iran <i>S. Mohammad, S.Y. Rohani, N. Ganjian, M. Rahimi-Dizadji</i>	II-575
Studies on creep behaviors of Lianghekou rockfill by triaxial tests <i>Li Haifang, Wen Yanfeng, Zhang Yinqi, Sun Geng, Jin Wei</i>	II-589
Proposing optimum concrete mix design in RCC dams <i>Nima Tavakoli Shirazi, Gholamreza Azizyan, Alireza Negahdar</i>	II-598
Phenomenon Lime Leaching At Balambano Dam <i>Anom Prasetyo, Pamrih Pammu, Yusri Yunus</i>	II-608
Lessons From Way Ela Natural Dam and Another Potency In Indonesia <i>Ahmad Taufiq, Dessy Rosliani, Djoko Mudjihardjo</i>	II-618
Dam Performance in Porous Foundation (Case from Nadra Dam, Cilegon) <i>Ahmad Taufiq, Diah Affandi, Dessy Rosliani, M. Budi Saputra</i>	II-629
Management Of Dam Gates : Precautions Against Failures And Aging	II-644

<i>D.R. Mahajan</i>	
The Inspection Of Sabodam Design To Ensure the effectiveness And Safety <i>I. Prinadiastari, F.T. Yunita</i>	II-654
The Development of a Risk Register for an Early Contractor Alliance Dam Upgrade <i>K.E. Mc Cann, H. Hawson, B.W. Wilson.</i>	II-664
Design of cut off wall for Al-Wand dam due to the complex geological condition of foundation <i>Ghanim M.H. Al-Sultan, Riyan A.H. Al-Obaydi</i>	II-671
Adopting remote sensing in dam surveillance <i>G. Grzanic, Ø. Lier &amp; I. Ekström, Y. Larsen &amp; T.R. Lauknes</i>	II-678
Instrumentation Utxesa Dam <i>Felipe Río Iglesias, Francisco José ConesaBaños</i>	II-688
An investigation onthe bulging phenomenon in the clay core of rockfill dam based on the stress and pore water pressure data <i>J. BolouriBazaz , H. Gholami, M.T. BolouriBazaz</i>	II-696
Reinjection Of Vertical Joints In Arch Dams By Means Of High Pressure Resins <i>Alberto Gonzalo</i>	II-707
Resistance of Concrete Dams to Natural and Anthropogenic Impacts <i>V. Sudakov, A. Pak</i>	II-716
Application of BOTDA based Optical Fiber Strain Sensing Technology in Spiral Case Preloading Filling Test <i>CUI He-Liang, WANG Yu-Jie, Zheng Xiao-Hong, Pengshu-Sheng</i>	II-720
Effect of Foundation Flexibility on Seismic Response of Concrete Gravity Dams <i>Bakenaz A. Zeidan</i>	II-727
Could the failure of teton dam have been prevented with an efficient monitoring plan? <i>J.F.A Silveira</i>	II-739
Experiment Study On Changes Of Sediment Erosion And Deposition In The Reach Of Chongqing City Under Different Conditions Of Water And Sediment <i>WANG Jun, CHENG Chuanguo, WU Huali</i>	II-748
Clarification on Hydraulic Characteristics of Labyrinth Spillway with Large Discharge Capacity Applied to Nam Ngiep 1 Hydropower Project <i>Yushi AOSAKA, Makoto ASANO, Makoto ASAKAWA &amp; Junichi MIZUTA</i>	II-753
<b>Sub Theme 3: Challenges in tailing dam (TD) project</b>	
Design Optimization of Bauxite Residue Dam in Connection with Environment and Land Acquisition <i>Agus Fitriyanto, Widya Taruko</i>	III-1
Design and construction of an exposed geomembrane sealing system for the Sar Cheshmeh tailings dam raising in Iran <i>Craig Noske, Alberto Scuero, Piero Sembenelli, Gabriella Vaschetti</i>	III-11
Tailings Storage Risk Reduction by Integrated Waste Management Mine at Didipio Mine <i>D.M. Brett, R.J. Longey, S.P. Edwards</i>	III-20
Manual For Design, Construction And Operation Of Tailings Dams In Iran <i>Vahid Faridani, Hamid Reza Tamannaie, Reza Baghi, Shahrokh Tahoumi</i>	III-30
Optimization of Tailings and Water Management Schemes in Taft and Daraloo Copper Mines, Iran <i>H. R. Seif, A. Roshdieh, H. Zaker</i>	III-35

Closure Of Acid Tailings Storage In A Tropical Jungle <i>John Phillips , Mark Hunte, Rio Tinto</i>	III-44
Comparison of tailings dams dynamic response in case of central and downstream method of construction <i>LjupchoPetkovski, StevchoMitovski</i>	III-54
Assessment of static and seismic stability of Kumtor’s gold mine tailings dam in Kyrgyz Republic <i>B.A. Chukin, R.B. Chukin</i>	III-64
Geotechnical Performance Evaluation of Sediment Dam A Case Study on Fiona Dam at PT Vale Indonesia Tbk <i>Wiyatno Haryanto, Anom Prasetyo</i>	III-73
<b>Sub Theme 4: Dams and water quality management</b>	
Upper Gotvand Dam and Hydro Power Plant Dealing With Salinity in Reservoir Challenges, Remedies and Evaluations <i>Satoshi Ojima, Yoshiaki Murakami</i>	IV-1
Integrated Approach for Environmental management in Teryu River <i>Yuichi Kitamura, Tetuo Murakami</i>	IV-11
LIDAR – ALS Application for Construction of the Numerical Model of the Dam Reservoir Bowl <i>S.C. Ooijens, I. Wieling, G. Busser</i>	IV-21
Comparative study on settling rate evaluation for soil particles in reservoirs <i>Hitoshi Umino, Noriaki Hakoishi</i>	IV-31
Multi-objective Reservoir Optimization upon Pareto Front Considering Reservoir sedimentation with Application to the Three Gorges Project <i>Fang-Fang Li, Jun Qiu, J.H. Wei</i>	IV-41
How water column stability affects the surface chlorophyll a in a deep subtropical reservoir and the time lags under different nutrient backgrounds <i>M. Zhang, Z.Y. Sun, M. Zhang, Q.H. Cai</i>	IV-49
Study and practice of reducing sedimentation in the tail area of the Three Gorges Reservoir <i>Zhou Man, Hu Xinge, Xutao</i>	IV-59
Biodiversity Management Planing The Project Areas Of Upper Cisokan Pumped Storage Hepp <i>Arief Heryana, Tona Indora, Akbar Nugroho</i>	IV-68
Reservoir sedimentation and the dredging solution <i>S.C. Ooijens, I. Wieling, G. Busser</i>	IV-75
Aerating Turbines at new Dam Toe Hydroelectric Power Plants at the existing Belesar & Peares Reservoirs (Spain) <i>V. Mendiola, G. Rodríguez</i>	IV-85
Effective Sediment Control In A Reservoir <i>Pranoto S.A., Suripin, Suharyanto, Djoko Legono, Isdiana</i>	IV-95
Ways to Improve Water Quality in Diponegoro Reservoir at Krengseng Watershed, Semarang <i>Grace Lucy Secioputri, RahmatKurniawan , Suseno Darsono, Sudarno</i>	IV-103
The Relationship Between Polycenropodidae Larva (Trichoptera) Abundance and Characteristic Sediment in Sempor Reservoir <i>KisworoRahayu, BondhanWiriawan&amp;Rr. Vicky Ariyanti</i>	IV-113
Simulating the effects of reduction in dam height on water quality of reservoir (case study: Baghan dam) <i>Seiedmorteza Rad, Bahman Yargholi, Fereidoon Karampour</i>	IV-121

Thermal and salinity Stratification Modeling of Dalaki Reservoir with the aim of agricultural use study <i>BahmanYargholi, Jahan Kadkhodapour, Fereidoon Karampour</i>	IV-131
Underground Dam in karst Region, case study Bribin Seropan Cave, Gunungkidul, Yogyakarta, Indonesia <i>Bani Nugroho, Pulung A. Pranantya</i>	IV-141
Water Quality Management by Free-selective Air-lock Intake <i>Hideaki Kawasaki, Hiroki Yamamoto, Kazuhiro Kuwahara</i>	IV-151
The new practical method for screening musty-odor / non-odor species in Oscillatoriales (Cyanophyta) <i>Fuminori Kimura, Takamitsu Homma, Ken Ushijima, Eiichi Furusato, Yasushi Tanaka</i>	IV-161
Assessment of Capacity and Water Level Profile at the Cidanau Head Work Sustaining Cidanau Headwork <i>Satyanto K. Saptomo, Budi I. Setiawan, Z. Akbar Murdiono, Rizqah Pangestu, M. Budi Saputra, Saritomo</i>	IV-171
Evaluating the Hydraulic of Cidanau Weirs Intake (Sustaining Cidanau Headwork Part 2) <i>Satyanto K. Saptomo, Budi I. Setiawan, AsepSuryadi, M. Budi Saputra, Muhammad Nasir</i>	IV-181
Study on Water Quality Assessment and Eutrophication Countermeasures of the Panjiakou-Daheiting Reservoirs <i>Hu Zuoliang</i>	IV-189
Sedimentation effect on daily inflow calculation in run of river dam type PLTA Bakaru <i>Wahyu Jatmika Hadi</i>	IV-200
Peer Study between Sediment Distribution Pattern in Reservoir Using Empirical Method and Estimation of Reservoir Real Life Time <i>Lily Montarich Limantara, Aniek Masrevaniah, Mohammad Bisri</i>	IV-207
Emergency response against water quality accident to secure safe watersupply for capital area <i>Satoshi Ojima, Yoshiaki Murakami</i>	IV-215
Daily Water Quality Forecasting System Linking Weather, Watershed, River and Dam Reservoirs Based On Numerical Simulation <i>Seung Jae Lee, Han Jin Lee, Chang Young Byun, Ji Won Kim</i>	IV-225
The Measures on Reducing Cracks and Improving the Quality of Concrete Face of CFRDs <i>Seung Cheol. Seo &amp; Hae Jin Yang, Heui Dae Lim</i>	IV-232
<b>Sub Theme 5: Catchment area management for sustainable dam development</b>	
Development of Bayesian Network Based Dam Risk Analysis And Its Application to Rockfill Dam in South Korea <i>Byoung Han Choi, Hyun-Han Kwon</i>	V - 1
Spatial Analysis to Identify Sources of Debris (Trees) Along Hydropower Rivers Case study Pite River, Sweden <i>A. Söderström, M. Hansson, M. Johansson, V. Carlsson</i>	V - 6
Development Of The Sediment Removal Suction Pipe By Laboratory And Field Experiments <i>M. Miyakawa, N. Hakoishi, T. Sakurai</i>	V - 15
Analysis on variation of soil erosion and sediment yield in the Three Gorges Reservoir reach <i>Xu Tao, Zhu Jun, Zhou Man</i>	V - 25
Decision Support System for water resources planning in Karun river basin <i>A. Heidari, E. Bozorgzadeh</i>	V - 35
Inter-basin Water Resources Development and Integrated Reservoirs System Bandung Operation for the Bandung Metropolitan, Indonesia <i>Ick Hwan KO, Adang Saf Ahmad, Byoung-Seub CHOI, Arie Moerwanto, Donny Azdan, Basuki Hadimuljono</i>	V - 46

Implementing a Sediment Transit Gate at Rizzanese Dam <i>P. Carlioz, V. Peloutier</i>	V - 56
Conservation Action Plan to Extend Life-Time of the Djuanfa Dam and HEPP <i>Herman Idrus, Anton Mardiyono, Elyawati Siregar</i>	V - 68
Sedimentation Management In The Cimanuk Watershed To Reduce Jatigede Dam Sedimentation <i>Adi Prasetyo, James Zulfan, Yiniarti Eka Kumala</i>	V - 78
Intake Vortex Flow Effect on Sediment Evacuation of Dam Reservoir using Physical Modelling <i>Zabihollah Zadeh, S.M. Kashefipour</i>	V - 86
Spatial Modeling of Cimuntur Catchment Area for Comprehensive and Integrated Watershed Management <i>Ajeng Aprilia, Kuntho Wibisono, Suharyanto, Harim Nugroho</i>	V - 97
The Percentage Of Reduction In Erosion Potential Using Horizontal Drainage <i>Akhmad Azis, Hamzah Yusuf</i>	V - 108
Implementation Concept Of Bio-Landscape Management Through Development Of Bio-Village At The Upper Watershed Of Dam <i>Sahid Susanto, Sigid Santoso</i>	V - 118
Construction of a Flood Retention Basin by Using Slight Erodible Loess <i>C. Boley, C. Meier, M. Rosport</i>	V - 127
Wonogiri Reservoir Sedimentation as Influenced by Change of Catchment Characteristics <i>D.A. Wulandari, S. Darsono, D. Legono</i>	V - 137
Sustainable sediment management engineering solutions for solving performance safety, performance and environmental sediment-related issues at Electricité de France (EDF) hydropower installations <i>D. Aelbrecht, E. Valette, J. Pralong, A. Clutier</i>	V - 148
Catchment Area Management For Sustainable Paselloreng Irrigation Dam In Connection With The Global Climate Change <i>Haryanto, Rahayu, Eka Rahendra, Subandi, Andi Muhammad Ratmiadi, Arif Paputungan</i>	V - 158
The basin management in the water resources development and construction in Jiaoxi River basin of China <i>Ye Shouren, Luo Jian, Zhang Yuanming, Wu Yongnian</i>	V - 169
Application of simple hydrologic model For predicting the effect of water conservation measures at the upper watershed of dam <i>Chandra Setyawan, Sahid Susanto</i>	V - 173
<b>Sub Theme 6: Challenges in dam safety policy and implementation</b>	
Diagnosis of the structural evolution of dams using dynamic monitoring data <i>R. Sarghiuta, A. Abdulamit</i>	VI-1
On-line dynamic monitoring of Cahora Bassa Dam ...the next level <i>Ezequiel Carvalho, Nilton Valentim, Chris Oosthuizen</i>	VI-11
Institutionalising Dam Safety Management System (DSMS) – Need of Interface- A Critical Study <i>K.V.V. Narasimha Rao, A. Narender Reddy, M. Giridhara Reddy CE,</i>	VI-21
Probabilistic Seismic Hazard Analysis Using Distance Attenuation Formula for Dams in Japan <i>Hideaki Kawasaki, Norihisa Matsumoto, Takashi Ikeda, Iwao Suetomi, Innpei Oshige</i>	VI-31
Fluctuation Monitoring System for Grain Size Distribution of Cemented Sand and Gravel Materials using Digital Image Analysis <i>K. Fujisaki, K. Kawano, I. Kuronuma, A. Takei</i>	VI-41

Rational, organized, and successful emergency operation against disaster case of the historic earthquake in Japan <i>S. Takagi, H. Izume, K. Someya, H. Ootaka</i>	VI-51
Development of Early Warning System Situ Gintung at Flood Period (Case Study: Disaster Situ Gintung March 27, 2009 in Jakarta-Indonesia) <i>PradahDwiatmanta, FajarBaskoroWicaksono, IdhamRiyando Moe</i>	VI-61
Concrete Support Structure for Hydroelectric Generators Subjected to Rotor Dynamic Loads <i>Tobias Gasch, Håkan Hansson, Richard Malm, ManouchehrHassanzadeh</i>	VI-67
The features of reliability and safety management of ash and tailings storage facilities in Russia <i>E.N. Bellendir, E.A. Filippova, O.A. Buryakov</i>	VI-77
Bagré dam early warning system: operation and perspectives <i>A. F. Millogo</i>	VI-86
Performance of Earth Dams Located over Active Faults (A case study) <i>M. Rezaifardi, A. Jalali</i>	VI-92
Uncertainty Analysis of Design Flood for Dam Risk Analysis Based on Multisite Rainfall Generator and Bayesian Rainfall-Runoff Model <i>Hyun-Hankwon, Jeong Yeullim, Ki Young Kim</i>	VI-102
Implementation of the Emergency Plan in LlacNegre Dam <i>Felipe Río Iglesias, Francisco José Conesa Baños, María Chacón Cano</i>	VI-108
An evaluation and comparison of rockfill dam behavior with instrumentation data during first impounding <i>J. Bolouri Bazaz, A. Khadem, K. Khajavi</i>	VI-117
Coordinated Emergency Preparedness Planning In Sweden <i>A. Söderström, R.Ascila, A. Engström Meyer</i>	VI-127
Probabilistic Assessment Of Rockfill Dam Breaking When Water Overflows The Dam Crest Or Its Core Top <i>OleksandrVaynberg, SergiiOsadchyi</i>	VI-137
Computer simulation of floods using hydrodynamic models with software systems MIKE 11, HEC-RAS, ISTRIC <i>O. Ye. Chernobyl</i>	VI-145
Safety of the existing dam at Kakhovka hydro scheme during the construction of a new hydropower plant within the dam <i>A.N. Zhakun</i>	VI-154
Deformation safety and its monitoring for high concrete face rockfill dams <i>Nenghui Li, Zhankuan Mi, Denghua Li</i>	VI-164
Study On Safety Management Solution And Emergency Response System For Dam <i>Xie Xiangrong, Weng Yonghong, Chen Shangfa, Yang Guang</i>	VI-173
Influence of Climate and Reservoir Water Level on the Gezhouba Dam Horizontal Displacement and its Monitoring System <i>CAO Wenbo, ZHU Weibin</i>	VI-186
Study on Face Slab Rupture and Safety Evaluation for Buxi High CFRD <i>Yao XU, Jinsheng JIA, Jutao HAO, Chun ZHAO, Jianming ZHAO</i>	VI-195
Abutment Stability Evaluation for Suoxi Arch Dam <i>Yu-JieWANG, Xiao-Hua HE, Bin LI</i>	VI-205
Internal Erosion, Environmental Challenges And Dam Safety <i>R. Bridle</i>	VI-216
Risk Analysis Adapted To Run Off River Dams <i>X. Bancal, O. Jullien, L. Duchesne, M. Scotti</i>	VI-227

Evaluation of Structural Health Monitoring in Embankment Dams using Time-lapse Inversion of 2-D Resistivity Data <i>K. Kim, M. Ha, H.-D. Lim, I.-K. Cho, D.H. Shin, D.S. Park</i>	VI-237
Measurement Of Cracks In Batutegei Dam, Lampung, Indonesia Using Gpr, A Case Study <i>Pulung Arya Pranantya, Mahdi Ibrahim, Djoko Mudjihardjo</i>	VI-247
Dynamic Analysis Of Morning Glory Tower Of Djuanda Dam Due To Maximum Credible Earthquake <i>Derry Indrawan, Mahdi Ibrahim T., Haris Eko Setyawan</i>	VI-267
Probability of failure of an embankment by internal erosion using the Hole Erosion Test <i>Thibaut Mallet, Khadija Outalmit, Symadrem, Jean-Jacques Fry</i>	VI-278
Lessons from 20+ years of experience and future directions of risk-informed dam safety management <i>D.N.D. Hartford</i>	VI-288
Dimensions of Population Health and Wellness in Determining the Safety of Dams and the Effectiveness of Emergency Plans: A Social Science Perspective <i>D.N.D. Hartford</i>	VI-298
Deformation Prediction Of A Large Cfsgd For First Impoundment <i>Ronald Haselsteiner, Resul Pamuk, Emre Kaytan, Volkan Ceri</i>	VI-308
Applicability of Manzari-Dafalias Constitutive Model to Rockfill Materials of Fill dam <i>Dong-Hoon Shin, Changho Choi</i>	VI-318
Re-assessment of Design Earthquake for The Upper Cisokan Pumped Storage Power Plant Project <i>J.C. Tzou, L. Luor, P.C. Hou, Netto Mulyanto</i>	VI-328
Improvement on Overall Dam Safety in Indonesia under Dam Operational improvement and Safety Project <i>S. Y. Hsu, W. H. Tsai, Tri Bayu Adji</i>	VI-338
Modern Tools For The Monitoring Of Dams <i>Jean-François Sageau, Hervé Lancon, Géraldine Camp, Pierre Brouillac, Pierre Carreaud</i>	VI-348
Stability and reliability analysis of the slope of supports for Haiqar Dam <i>B. Jahan Bekam Fard, M. Mokheri, Hossien Ali Lazemi</i>	VI-358
Study on Damage of Feitsui Arch Dam Caused by Earthquakes due to Rupture Of Nearby Faults Using ABAQUS <i>Yean-Seng Wu, Shin-Yuan Yu</i>	VI-371
Seismic Design Aspects of Rockfill Dam in Narrow Canyon Subjected to multiple seismic hazards <i>M. Wieland, H. Fallah</i>	VI-381
Application of Mega Project Management Tenets to Dam Safety Management and Modification Programs <i>James P. Moore</i>	VI-391
Seismic Analysis of Dam-Reservoir-Foundation Interaction for Concrete Gravity Dams <i>Bakenaz A. Zedan</i>	VI-396
Inspection of Gates and Insinuations for Dam Safety <i>D.R. Mahajan</i>	VI-409
Panama Canal Flood Control Program <i>Johnny a. Cuevas m.</i>	VI-419
Risk associated with natural dams formed by landslides Two recent case studies in Papua New Guinea and India <i>Richard Herweynen</i>	VI-429

Introducing the SAMANI-MODARRES Model as A New Non-Structural Method for Dam Safety Analysis <i>Roohollah, Mohammad Vali Samani, Lotfali Modarres</i>	VI-439
Rehabilitation and Automation of the Monitoring Instrumentation Dams in Macedonia <i>Slavko Milevski, Marjan Glavinceski, Ejup Bekiri, Helmut Stahl, Vincenzo Caci</i>	VI-449
Towards enhanced dam safety regulation in Sweden <i>M. Bartsch, A. Engström Meyer</i>	VI-459
Risk Management of Aging Dams in the Brantas River Basin Indonesia <i>Erwando Rachmadi, Didik Ardianto, Titik Indahyani, Raymond Valiant Ruritan</i>	VI-469
Risk Management In Dam Break Disaster: Lesson Learn From Way Ela Natural Dam Break Case <i>F. Tata Yunita, DyahAyu Puspitosari</i>	VI-478
Implementing a Geodynamic Monitoring System at Hydro Plants in Ukraine <i>E.S. Shchuchyk, O.V. Ruban, N.F. Voloshena</i>	VI-488
A Study of Identification Methods for on Instrument Values and Equipment Alarms at Hydroelectric plants <i>Luo Xiaoling, Zhu Jun</i>	VI-494
Reinforcement Balambano Dam Tailrace To Avoid Dam Collapse <i>Anom Prasetio, Pamrih Pammu, Yusri Yunus</i>	VI-503
Design and Construction of the Dam Sealing Structures of Arkun CFSGD <i>Resul Pamuk, Ronald Haselsteiner, Emre Kaytan, Volkan Ceri</i>	VI-512
Safety Assessment on Wadaslintang Dam "The Use of Geological Methods and Seismic Models to Determine Remedial Works" <i>Rr. Vicky Ariyanti, Faizal Adicondro, Andie Arif Wicaksono</i>	VI-522
Safety and Risk Aspects of Development of Incir HEPP Project From a Hydraulic Perspective <i>J. Brommundt, H. Stahl, V. Aslankara, M. Ersungur</i>	VI-532
Dam Break Analysis And The Emergency Action Plan <i>C. H. Lin, W. H. Tsai, Agus Jatiwiryono</i>	VI-542
Practical experiences in using SPANCOLD Guidelines on Risk Analysis Applied to Management of Dam Safety <i>I.Escuder-Bueno, L.Altarejos-García, A.Serrano-Lombillo, J.T. Castillo-Rodríguez, A. Morales-Torres, J. Fluixá-Sanmartín</i>	VI-551
Earthquake Vulnerability of Dams and Criteria for Selection of Dams in Seismic in Subject <i>M. Wieland</i>	VI-558
Applying Portfolio Risk Assessment to guarantee serviceability <i>Ian Hope, John Chesterton, Rob Gauldie, T.J. Hill</i>	VI-568
Research on the Effect of Freezing of Pumped Storage Power Station upper Reservoir' bank in Cold Regions <i>Zhigong Jin, Yanbin Xu, Donghe Ma</i>	VI-579
Estimating Of Water Total Suspended Solids (TSS) Using Landast 8 Imagery in Jatiluhur Reservoir <i>Mouli De Rizka Dewantoro, Iswiditya Andi Hapsara, Budi Darmawan Supatmanto</i>	VI-584
Long term ambient vibration monitoring of RoodeElsberg dam- initial results <i>Patrick Bukenya, Pilate Moyo, C. Oosthuizen</i>	VI-594
A Case Study on Standard Operation Procedure (SOP) for Cascade Operation of Three Reservoirs in Citarum River Indonesia <i>ZafarMasoodSiddiqui, Mohammad Khan</i>	VI-603
Sarsang Stronghold Ground Phisicomechanical Qualities Observation <i>A.A. Sarukhanyan, M.M. Mkrtumyan, L.H. Levonyan</i>	VI-614



Drones To Monitor Dams: An Optimized Intervention <i>Paul-Henri Faure, Laurence Duchesne, Vincent Tournade, Bruno Moulin</i>	VI-620
Human Supervision At The Heart Of The Monitoring System <i>Laurence Duchesne, Francoise Abadie, Paul Tap, Optim Resources</i>	VI-630
A presentation about optimized method for calculation of piezometric technical specifications and total pressure cell in earthen dams <i>Meysam Rezaie Ahvanooie, Maryam Hamta, Mahdi Jalili</i>	VI-640
Basic Dam Safety Studies For Existing Dams In Iran <i>S.F. Fakhrmoosavi, M. Ghaemian, A. Noorzad</i>	VI-646
Future Inflow Simulation Considering the Uncertainties of TFN model and GCMs on Chungju Dam Basin <i>J.Y. Park, J.H. Kwon</i>	VI-655
<b>Sub Theme 7: Dam operation in connection with climate change</b>	
Adaptive dam operation to maximize power generation without jeopardizing food security on the Orange River system <i>B. Mwaka, M. Williams</i>	VII-1
Study on Enhancement of Hydroelectric Power Generation by Utilizing Plain Dam In Shinano Rive <i>Koji Asai, Shinya Mitsuishi, Nobuyuki Kawamoto, Takashi Izumiya, Yuya Sasaki</i>	VII-10
Management of Design Flood Issues in Existing Dams under Climate Change <i>A.B. Pandya, N. K. Goel, &amp; B.R.K. Pillai</i>	VII-20
Increasing the minimum residual flow at Monstalvens Dam (Switzerland) <i>F. Blasi, L. Savoldelli</i>	VII-30
An assessment of the effects of reservoirs storage on water availability under climate change scenarios <i>A. Granados, L. Garrote, A. Iglesia, F.J. Martín-Carrasco</i>	VII-37
Optimal Operation of Multi-Objective Two Reservoir System <i>N. Abolvaset, V. Nourani, A. Mihandoost</i>	VII-46
A Role Concept of Reservoir Operationin Sustainable Water Supply to Subak Irrigation Schemes. Case Study of Yeh Ho River Basin <i>Mawiti Infantri Yekti, Bart Schultz, I Nyoman Norken, Laszlo Hayde</i>	VII-56
The cyber-security policy of dispatching automation system in Jinsha River's Cascade Large Dams operation <i>Liu Yu</i>	VII-69
Methane Gas Emission In The Pool Of Gajah Mungkur Reservoir <i>Wawan Herawan, Yan Adhitya, Wesda Wardhana</i>	VII-77
Optimalization Of Dam Operation Using Rainfall Prediction Model, Case Study : Darma Dam, Kuningan-West Java <i>Deny Ramadhani, Arno Adi Kuntoro, Donny Azdan, Abdul Malik Sadat Idris</i>	VII-87
Operation of Estuary Barrage and Weirs in the Nakdong River during the Flood Period <i>K.S. Jun, K. Min, M.J. Kim</i>	VII-95
Effective Dam Operation To Combat Floods Associated With Climate Change In Nigeria <i>Engr. Imo E. Ekpo, Musa Aminu</i>	VII-105
Operation of KedungOmbo Reservoir by Use of Linear Decission Rule (LDR) <i>Suharyanto, Sri Mulyani</i>	VII-112

Management of Reservoirs Control Water Level (CWL) : Climate Change Adaptation Strategy at Brantas River Basin <i>D. Ardianto, Harianto, E. Rachmadi</i>	VII-121
Moroccan experience in monitoring and inspecting the hydraulic equipment and the implementation of dam safety <i>Akalay Mohammed Bachir, Soualhine Mina</i>	VII-130
Are we sustainable? The threads for hydropower <i>M. Detering</i>	VII-139
The sluice gate management system for Yangtze River mainstream dams operation <i>Liu Yu, Li Hui</i>	VII-146
Flood Analysis for Spillway Discharge Capacity and Increasing Reservoir Storage for Dam Improvement from Overtopping and Dam Break for 6 Reservoir in Lower Mae-Nugt Basin, Mae-Tang district, Chiangmai Province, Thailand <i>Chatchai Pedugsorn, Januwat Lertsilpachalearn, Jirachai Patanapongsa</i>	VII-155
Multipurpose Water Uses of Hydropower reservoirs: On-going Frameworks and Examples <i>Emmanuel Branche</i>	VII-165
Citarum Cascade Dams Operation to Secure Domestic, Municipal and Industry (DMI) Water and Climate Change Adaptation <i>Herman Idrus, Anton Mardiyono</i>	VII-175
Decision Support System Technology for Water Resources Management In Citarum River Basin – Indonesia <i>Harry M. Sungguh, Reni Mayasari, Hendra Rachtono, Gok Ari Joso Simamora</i>	VII-186
Effective Dam Operation To Combat Floods Associated With Climate Change In Nigeria <i>Engr. Imo E. Ekpo, Musa Aminu</i>	VII-196
Sharing Water From Bili Bili And Jenelata Reservoir For Irrigation And Water Drinking Development In Connection With Global Climate Change <i>Feriyanto Pawerunsi, Adi Umar Dani, Subandi, Eka Rahendra, Sumardji, Pandu S.W. Ageng, Hermawan</i>	VII-203
Big Dam Reservoirs and Their Role in Limiting the Consequences of Floods and Droughts in Poland <i>J. Winter, E. Sieinski, A. Wita, A. Kosik</i>	VII-213
Water reservoirs and expected climate changes <i>E. Bednárová, M. Minárik, B. Lipták, A. Kasana, P. Mackovjak</i>	VII-219
Operation of Large Dams under Changing Under Changing Climate Climate Case Study on Kotmale Dam –Sri Lanka <i>W.A.Chandrathilaka</i>	VII-227



## Estimation of Water Balance for Maninjau Hydropower using TRMM and Discharge Data

Bambang Istijono  
Department of Civil Engineering, Andalas University

Revalin Herdianto  
Department of Civil Engineering, Politeknik Negeri Padang, Corresponding author

Dalrino  
Department of Civil Engineering, Politeknik Negeri Padang

Adek Rizaldi  
Balai Wilayah Sungai V Sumatera

Flow from Lake Maninjau in Agam Regent, West Sumatra, is used to generate a 68 megawatt hydropower and to irrigate 4200 ha paddy field. There are 19 rivers flowing into the lake, with main rivers being Batang Limau Sundai, Batang Maransi, Bandar Ligin, Jembatan Ampang, Batang Kalarian and Tembok Asam. Its outflow from hydropower station flows to Batang Antokan which ends in the Indian Ocean in the West. Water balance for both inflow and outflow from 2009 to 2012 show an increase from an average of 5.8 m<sup>3</sup>/second to 23.53 m<sup>3</sup>/second. This condition raised a concern that rainfall input cannot maintain sustainable water level. In addition, an instant discharge measurement on 25 and 26 March 2013 shows that input to the lake was smaller than the output. An initial study suggested that the discrepancy is due to an effect of ground water. However, this study did not confirm this through a field or model study.

The Tropical Rainfall Monitoring Mission (TRMM) has long been used as an auxiliary data for both prediction of rainfall in ungauged basins and for simulation in hydrological models that require spatially distributed rainfall input. We use daily TRMM data over the Lake Maninjau catchment from year 2000 to 2010 TRMM in 0.5° x 0.5° grid resolution in order to match ground measured rainfall. DEM (Digital Elevation Model) of SRTM (Survey Radar Topographic Mission) CGIAR-CSI in 90-m resolution. The data are validated using ground measured rainfall data from the station. Preceding studies show that high rainfall is over estimated and low rainfall is under estimated. In our study, we find that rainfall flow is predominant during rainy season that contributes to dams outflow. Yet we haven't found any data that supports the contribution of subsurface flow into the outflow.

Keywords: TRMM, DEM, rainfall, outflow

## 1. Introduction

Lake Maninjau is situated in Tanjung Raya District, Agam Regent. The type of the lake is tectonic volcano, comprising an area of 9.500 ha, 461 m above sea level. Tanjung Raya district surrounding the lake has a total area of 24.400,03 Ha surrounded by steep topography. Main rivers flowing into the lake are Batang Limau Sundai, Batang Maransi, Bandar Ligin, Jembatan Ampang, Batang Kalarian dan Tembok Asam. Outflow flows solely through Batang Antokan that ends in the Indian Ocean in the west. The outflow is used for hydro power of 686 MW as well as for irrigation of paddy field of 4200 ha. Topography classes consist of flat (0 – 8% slope), mild (8– 15%), fairly steep (15–25%), steep (25–40% ) and very steep > 40%. Topography in the North-West is fairly flat (0-2% of 115,51 ha). Topography in the East-South is hilly with slope of >15% as much as 95.79 ha.

Table 1. Inflow and outflow of Danau Maninjau  
From instant measurement, 25-26 March 2013

No.	Tributaries/Location	Discharge m <sup>3</sup> /s
1	S. Maransi, Jorong Gasang Maninjau	0,044
2	Batang Air Karambia , Bayur	0,047
3	S. Rengah, Bayur	0,573
4	S. Bandar Katik, Bayur	0,588
5	S. Batang Banduran, Bayur	0,103
6	S. Banda Koto, Bacang Koto Malintang	0,063
7	S. Languang, Koto Malintang	0,058
8	S. Bandataruka, Jorong Pauah Koto Malintang	0,135
9	S. Sape, Jorong Pauah Koto Malintang	0,345
10	S. Tan Malayu, Jorong Rambay Koto Malintang	0,117
11	S. Muara Kurambi, Jorong Baruan Koto Gadang	0,751
12	S. Muara Suau, Jorong Baruah Koto Gadang	0,690
13	S. Jaus, Koto Gadang	0,497
14	S. Asam, Pasar Rabaah Koto Kaciak	0,636
15	S. Kulirah, Pasar Rabaah Koto Kaciak	1,227
16	S. Limau Sunday, Jorong Kugu Baru Maninjau	0,147
17	S. Balok Jorong Bancah, Maninjau	0,069
18	S. Tumayo, Jorong Kukuban Maninjau	0,036
19	S. Muara Pisang, Jorong Pasar Maninjau	0,316
	Sum of inflow	6,442
	Outflow	
1	Batang Antokan	14.13

Source: Dinas PSDA Sumbar

Instant measurement on 25 and 26 March 2013 shows that input inflow is smaller than the outflow (Table 1). There is a discrepancy between inflow and outflow that cannot be explained by hydrologic measurement alone. This condition raises a concern that it may disrupt the operation of the hydropower since the outflow into Batang Antokan does not reflect water use by turbine, and the outflow cannot be controlled by power plant operator. This condition raised two hypotheses. First, the difference between outflow and inflow results from subsurface flow from soil surrounding the lake. Secondly, the difference results from direct precipitation on the lake surface. There is no research that has been done to answer this question due to difficulty in measuring parameters related to the problem. Therefore, indirect method is proposed in this study by the use of satellite data.

## 2. Methodology

Secondary data for rainfall, discharge, and land cover are gathered from Dinas PSDA Sumatera Barat. Quantitative analysis is employed in this study. Topographic map is processed from DEM (Digital Elevation Model) from SRTM (Survey Radar Topographic Mission) CGIAR-CSI in 90 m. Rainfall data are processed from TRMM over Lake Maninjau dari tahun 2000 to 2010 TRMM in  $0.5^\circ \times 0.5^\circ$  resolution. Sampling points are taken around the lake (6 points) from the TRMM and are labelled as in Fig. 1. Data are processed to obtain daily rainfall time series for further analysis.

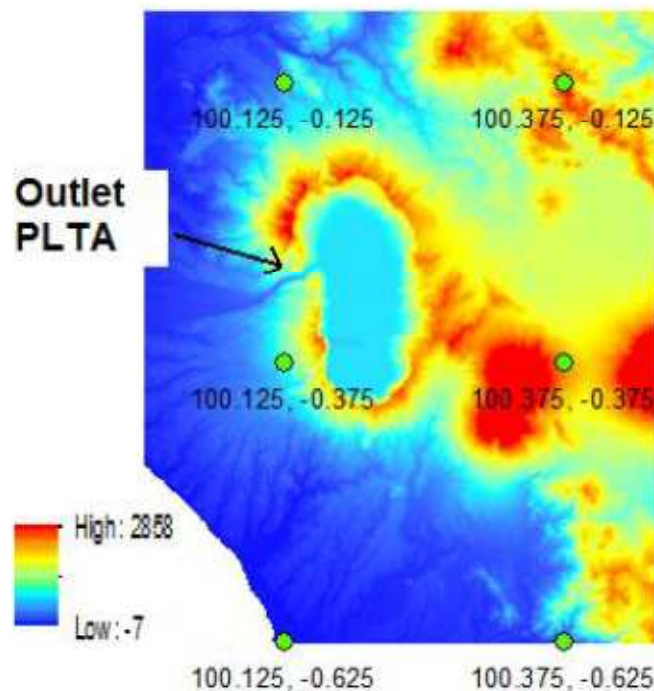


Figure 1. Topographic map of Lake Maninjau and TRMM sampling positions.

### 3. Results and Discussion

Rainfall data from Maninjau station from 1984-2000 shows that monthly rainfall average is 299 mm, and annual rainfall over this period is 3661 mm. The wettest month is November and the driest month is June. Annual rainfall exhibits a decline trend over the period. For instance, in 1984 the rainfall is 1984, but in 2000 it drops to 2000 about 50 %.

Discharge for hydro power is approximately the same with outflow into the river. Discharge measurement from 19 rivers flowing into the lake on March 26, 2013 shows that total discharge is 6.44 m<sup>3</sup>/s. This discharge is fairly small compared to annual average outflow. There is an indication that some portion in the outflow comes from direct rainfall and subsurface flow of the catchment.

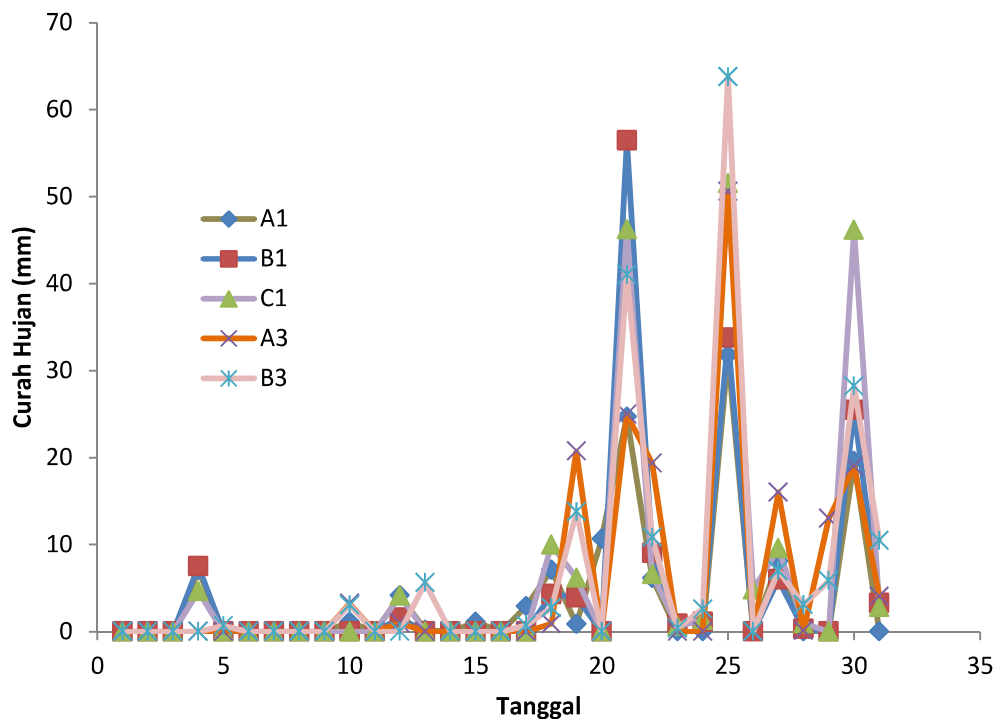


Figure 2. TRMM in March 2013

To confirm these hypotheses, we plot TRMM data in March. TRMM data shows that on 25 March there is rain around the lake. There is no rain on 26 March. Maximum point rainfall is 63 mm. Assuming all rainfall flows into the lake surface, maximum discharge due to the rain can be calculated as:

$$Q = (63/1000) \times 9500 \times 10000 / (24 \times 3600) = 69.27 \text{ m}^3/\text{second}.$$

that comes solely from the rain. If subsurface flow is taken into account, we need to estimate time to reach the lake from topmost ridges and retained flow by local topography after the rainfall event.

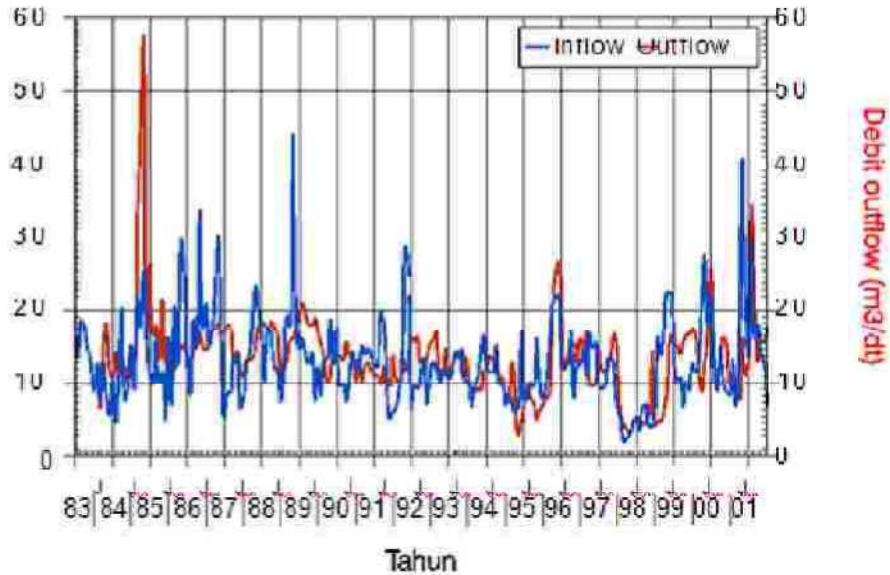


Figure 3. Inflow and outflow of Lake Maninjau 1983-2001 (Source: Dinas PSDA Sumbar)

Fig. 3 shows that fluctuation of outflow is almost in phase with the inflow. This indicated that both surface precipitation and surface runoff may have significant contribution to the outflow.

Table 2. Discharge in Batang Antokan in 2009-2011

No	Month	2009	2010	2011
1	January	4,72	14,00	30,00
2	February	5,01	13,20	30,50
3	March	3,84	20,80	28,20
4	April	4,71	24,30	25,60
5	May	3,15	38,70	17,70
6	June	3,34	20,40	10,60
7	July	1,82	14,60	31,80
8	Agust	5,13	17,00	18,60
9	September	9,01	17,40	19,20
10	October	7,52	20,70	31,40
11	November	11,31	17,60	18,50
12	December	10,08	20,40	20,30
	Average	5,80	19,93	23,53

Source: Dinas PSDA Sumbar

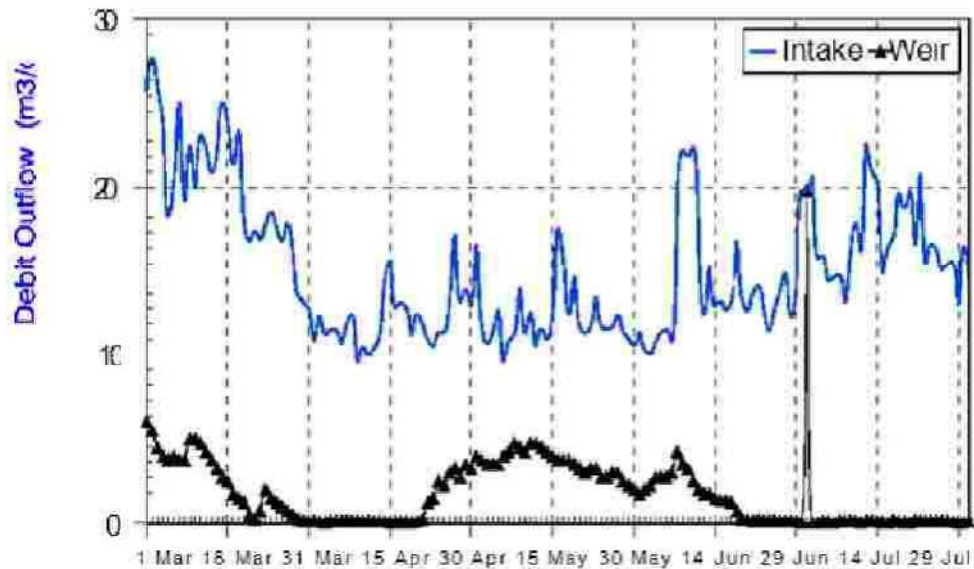


Figure 4. Flow to hydropower intake in 1984.  
Source: Dinas PSDA Sumbar.

Inflow and outflow between 1983-2001 shows that outflow is smaller than inflow.

In three years, there is an increase in the outflow of the Antokan. In the mean time there is no increase in rainfall that contributes to the flow (Table 2). Theoretically, this is only possible by subsurface flow. Yet, retention time from rainfall events to the subsurface flow remained questioned.

#### 4. Conclusion

Analysis of TRMM and ground-measured rainfall shows that the difference between inflow and outflow comes from direct rainfall over the lake. Yet, TRMM alone does not explain the remaining flow after rainfall events. This leads to another hypothesis that subsurface flow plays an important role in the inflow magnitude. However, we cannot prove the contribution of the tributaries in the inflow component. This is important in water conservation i.e. priority area among the tributary's sub catchment. There is an opportunity to study the contribution of subsurface flow in the difference on inflow-outflow.



## Reference

Dinas PSDA Sumatera Barat. 2013. “Studi Konservasi Kawasan Danau Maninjau di Kabupaten Agam Propinsi Sumatera Barat”.

Grayson, R. & Blöschl, G. (eds) 2000, Spatial Patterns in Catchment Hydrology, Cambridge University Press, Cambridge.

Singh, V. P. 1989, Hydrologic Systems, 2 vols, Prentice Hall, Inc., New Jersey.