# The Fifth International Symposium on Flash Floods in Wadi Systems (ISFF2020)

ISFF

Kyoto, Japan
Date: 25th - 28th February 2020

KYOTO UNIVERSITY FOUNDED 1897 KYOTO JAPAN

DPRI-KU

WRRC Kyoto University

GADRI Global Alliance of Disaster Research Institutes

MEXT MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

# The Fifth International Symposium on Flash Floods in Wadi Systems (ISFF2020)

## Disaster Risk Reduction and Assessment for the Flood Prone Urbanized & Archaeological Wadis in Middle East and North Africa MENA Region

**Website:** www.isff-ku.com

**Venue:** Obaku Plaza Kihada Hall

Kyoto University, Gokasho, Uji, Kyoto, Japan

**Organized by**

Water Resources Research Center (WRRC)

Disaster Prevention Research Institute (DPRI)

Kyoto University, Kyoto, Japan

**Supported by**:

Japanese ODA Grants for Projects relating to UNESCO

Global Alliance of Disaster Research Institutes (GADRI)

# Partners and Sponsors












# Contents

# Welcome Message

"On behalf of the organizing committee, It is a distinct pleasure and privilege to welcome friends, colleagues, and participants from all over the world to the 5th International Symposium on Flash Floods 2020 (5th ISFF 2020), which will be held from February 26 to 28, 2020, at Kyoto University – Uji Campus, Japan.

This intensive symposium will host 7 technical sessions concerning flash floods issues, poster presentations, and a special seminar on flash flood risk at UNESCO World Heritage Sites. The topics of the symposium truly reflect the trends, recent advances and application of different new approaches in the different parts of the world.

It also offers a genuine opportunity for young scientists starting their research activity in flash floods issues in the Middle East North Africa (MENA) region and other parts of the world. This gathering of experts represents an opportunity to make the voice of flash floods awareness heard. It is a truly global symposium with speakers from Asia, North Africa, the Middle East, and Europe presenting their latest results on new techniques and new approaches that will revolutionize the field of flash flood mitigation and consciousness.

Your attendance will make the symposium an unforgettable scientific endeavour and will stimulate a creative exchange of knowledge and networking among different international institutes in all over the world.

We would like to sincerely appreciate your attention and we look forward to seeing you in Kyoto this February."

Tetsuya Sumi
Professor
Director of Water Resources Research Center,
Disaster Prevention Research Institute
Kyoto University

# Preface - English

The Water Resources Research Center (WRRC) and the Global Alliance of Disaster Research Institutes (GADRI) of the Disaster Prevention Research Institute (DPRI), Kyoto University, initiated an international symposium on WFFs and established research activities with various MENA countries, including Egypt, Oman, Morocco, Tunisia, Jordan, Saudi Arabia, and Sudan. At Kyoto University, we organized the 1st International Symposium on Flash Floods in Wadi Systems (ISFF), from 14-15 October 2015, to investigate flash flood disasters, to implement new research methodologies, and to emphasize transdisciplinary approaches in this ever more important field of research. The goal of the event was to bring together experts from governments, universities, and companies in the flash flood field from Japan, Egypt, Sudan, Jordan, Oman, Saudi Arabia, and Europe to provide a platform to present the current areas of investigation, especially in the fields of atmospheric and water-related disaster and integrated disaster risk management, to encourage the formation of joint research cooperation programmes. The event was organized and hosted by the WRRC and jointly sponsored by the GADRI.

After the first ISFF, we initiated the ISFF project, which focuses on the existing gaps for flash flood case studies from 6 Arabian countries, to ensure an integrated strategy and water resource management for wadi systems in the Arabian region. The topic of flash floods was investigated from several aspects, including hard structural and soft non-structural measures, issues of floodwater harvesting, guidelines, hydrological modelling and warning systems. Based on our discussion during the 1st ISFF, we drew 5 years of roadmaps for the ISFF project, and we found substantial efforts by governments in the MENA region to enhance WFF monitoring, modelling, mitigation structures and warning systems. However, gaps remain that need a new paradigm shift considering comprehensive strategies, mitigation and water resource management. We need to conduct more research and establish guidelines/manuals for assessment, mitigation and utilization of floodwater. Later, based on the success of the 1st ISFF, Kyoto University initiated an ISFF series that focused on DRR by discussing current mitigation measures for WFF and water harvesting.

We organized a training course to help participants from Egypt, Jordan, Sudan and Yemen within the framework of the UNESCO Japanese Fund-In-Trust (JFIT) project titled "Urgent Capacity Development for Managing Natural Disaster Risks of Flash Floods in Egypt,

Jordan, Sudan and Yemen", to predict and implement warning systems and hazard mapping for target wadis in each country. The course supported participants in developing flash flood prediction and management scenarios by using the integrated flood analysis system (IFAS) and rainfall-runoff-inundation (RRI) model as well as GIS and remote sensing (RS) methods introduced by the International Centre for Water Hazard and Risk Management (ICHARM), Japan. Participants from the four countries were introduced to various aspects of hydrological modelling, flood hazard mapping and integrated management of flash floods. The training was designed to increase the audience's awareness of the WFF risk mapping, leading to better performance in flood risk reduction in the targeted wadi areas. The major objective of this training was to introduce numerical models developed from ICHARM to assess future WFF risk, potential water harvesting, challenges in making decisions during early warning, and structural mitigation measures.

Then, an annual series of ISFF projects was initiated, and the 2nd ISFF was hosted by the TUB-El Gouna campus in Egypt and focused on case studies, the UNESCO project, water harvesting, and social aspects. In 2017, the 3rd ISFF in Oman was organized at GUTech in Muscat, focusing on risk assessment, management, hazard mitigation, etc. In 2018, the 4th ISFF was hosted by Hassan II University in Casablanca, Morocco. The 5th ISFF will be held in Kyoto in 2020.

Priorities will be defined during the 5$^{th}$ ISFF and updated roadmap for future research challenges, gaps, and potential projects for flash floods in urban, World Heritage UNESCO Site (WHS), and wadi systems. ISFF annual series have various objectives: 1) to form a platform for networking and sharing experiences and data among some MENA countries, scientists and authorities, 2) to stimulate cooperation among researchers in fundamental and applied sciences towards WFF research, 3) to introduce Japanese technologies to help in WFF protection and ground harvesting, and 4) to develop new creative ideas and projects to adapt to and mitigate WFFs.

# Preface – 日本語

京都大学防災研究所水資源環境センターと世界防災研究所連合（Global Alliance of Disaster Research Institute （GADRI））はワジ流域におけるフラッシュフラッド（ワジ・フラッシュフラッド，WFF）に関する国際シンポジウムをスタートし，エジプト，オマーン，モロッコ，チュニジア，ヨルダン，サウジアラビア，スーダンを含む中東・北アフリカ（Middle East & North Africa，MENA）地域と共同研究を実施している．京都大学では，ワジ流域におけるフラッシュフラッドに関する国際シンポジウム（International Symposium on Flash Floods in Wadi Systems，ISFF）を 2015 年 10 月 14－15 日に開催し，フラッシュフラッドによる洪水被害を調査し，新たな研究手法を用いて，今後ますます重要となると考えられるこの課題について学際的なアプローチを進めることとなった．ISFF の目的は，日本，エジプト，スーダン，ヨルダン，オマーン，サウジアラビアおよびヨーロッパ諸国から政府，大学，企業のフラッシュフラッドの専門家が集まり，水害や総合的な災害リスクマネジメントについて現在行われている研究成果を共有するとともに，今後の共同研究のきっかけをつくることである．ISFF は水資源環境センターが主催し，GADRI の後援で開催された．

第 1 回 ISFF の開催後，ISFF プロジェクトが本格的に始動し，アラブ諸国のフラッシュフラッドに関する事例の相違に着目して，アラブ地域におけるワジのフラッシュフラッドに関する統合的な対策と，関連する水資源管理方策を確立することとした．フラッシュフラッドの課題は，ハード対策とソフト対策，洪水の水資源利用，ガイドラインの策定，水文モデルや避難情報伝達システムなど様々な視点から研究がなされてきた．第 1 回 ISFF での討議結果に基づき，ISFF プロジェクトとして 5 か年計画が立てられ，MENA 地域の政府によってワジのフラッシュフラッドモニタリングやモデリング，ハード対策や避難情報システムについての取り組みが行われた．しかし，パラダイムシフトを要する包括的な対策や防災，水資源管理などの課題は未だに残っており，さらなる研究と，洪水の評価や被害の軽減，洪水の有効活用のためのマニュアルやガイドラインの作成が必要となる．第 1 回 ISFF の成功を受け，京都大学では現状のワジのフラッシュフラッドによる被害を軽減する対策と水資源利用について議論し，災害リスクの軽減に着目した ISFF を引き続き開催することとなった．

水資源環境センターでは，エジプト，ヨルダン，スーダン，イエメンにおけるフラッシュフラッドの災害への緊急対策と題してユネスコの Japanese Fund-In-Trust(JFIT)プロジェクトにおいて，これら諸国からの参加者に向けた研修を実施し，災害の予測や避難情報伝達システム，ハザードマップの作成を各国のワジ流域を対象に行った．この研修では，GIS やリモートセンシングに加え，日本の水災害・リスクマネジメント国際センター（International Centre for Water Hazard and Risk Management，ICHARM）が導入した IFAS（Integrated Flood Analysis System）や降雨流出氾濫モデル（Rainfall- Runoff Inundation (RRI) model）を用いてフラッシュフラッドの予測や対策のシナリオを作成するための支援を行った．参加者は水文モデリング，

ハザードマップ，フラッシュフラッドの統合的マネジメントなどの研修に取り組んだ．研修ではワジのフラッシュフラッドのリスクマップに対する関心を高め，ワジ流域で洪水被害をより軽減することを目指しており，具体的にはワジのフラッシュフラッドの将来のリスクや水資源利用のポテンシャル，災害の初期段階における意思決定やハード対策などを評価するために，ICHARM が開発した数値モデルを紹介することを目的としていた．

その後，年に 1 度の ISFF プロジェクトが始まり，第 2 回 ISFF がエジプトのベルリン工科大学（TUB）エルゴナキャンパスで開催され，事例研究やユネスコのプロジェクト，水資源利用，社会的課題に焦点があてられた．2017 年には第 3 回 ISFF がオマーンのマスカットの GUTech で開催され，リスク評価やリスク管理，防災などが議題となった．2018 年にはモロッコのカサブランカの Hassan II University で第 4 回 ISFF が開催され，都市域の洪水問題も取り上げられた．そして 2020 年には，これまでの４回の会議を総括する形で京都で第 5 回 ISFF が開催される．

第 5 回 ISFF では，都市域やユネスコの世界遺産などの課題を含め，ワジ流域におけるフラッシュフラッド対策の今後の研究課題やプロジェクトが討議・共有される予定である．ISFF の目的としては，1)MENA 地域の研究者や政府間でネットワークを作り，データや経験を共有する，2)ワジのフラッシュフラッドに関する基礎的研究，応用研究における相互協力を促進する，3)ワジのフラッシュフラッド対策や地下水利用を支援する日本の技術を紹介する，4)ワジのフラッシュフラッドに適応し，被害を軽減するための新たなアイデアやプロジェクトを創出する，ことである．

## Organizing Committee

Tetsuya Sumi
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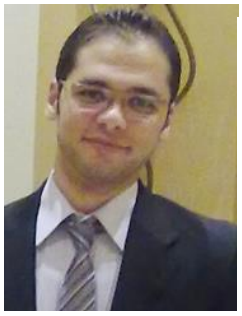

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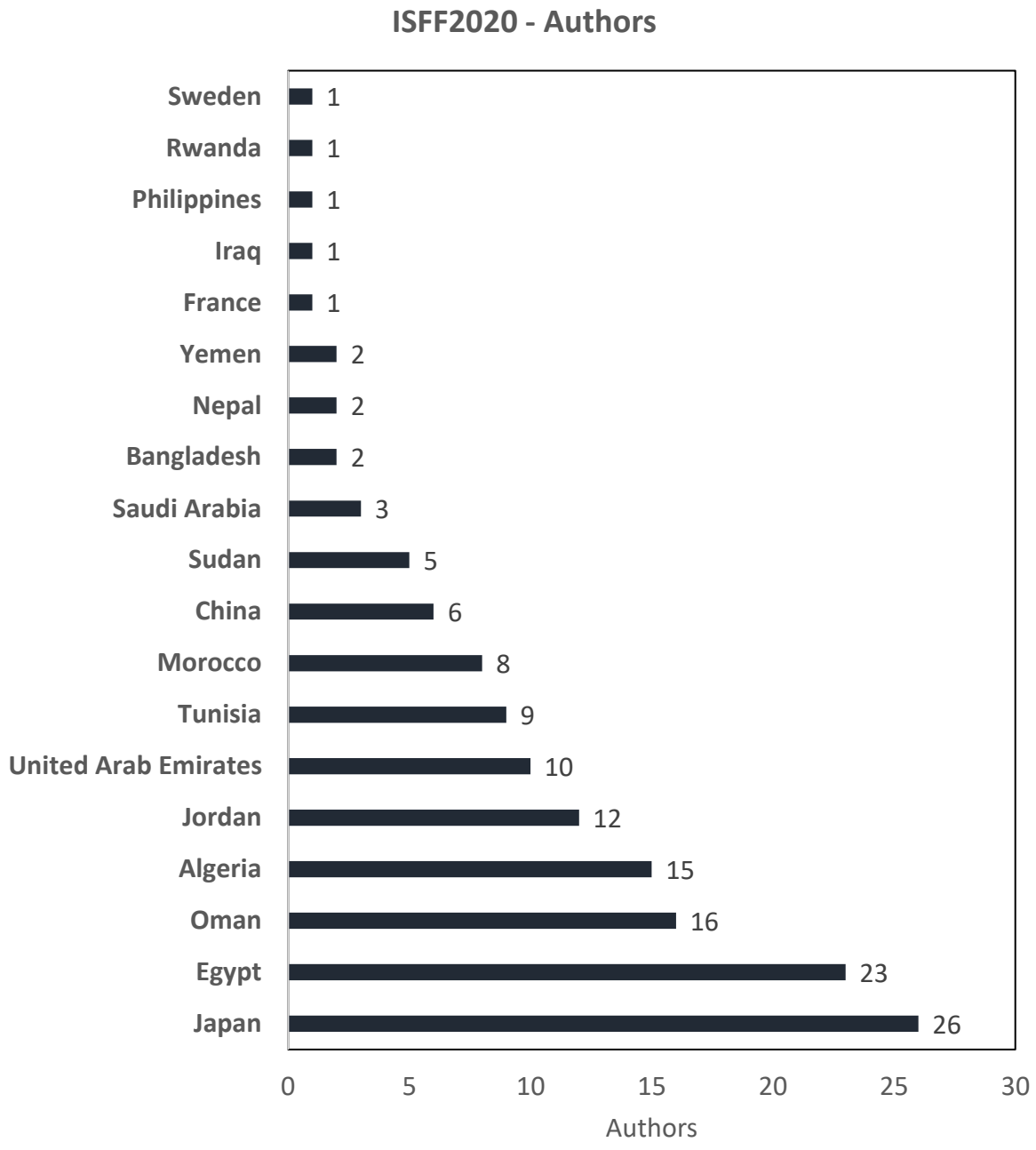
## ISFF2020 Statistical Information



# International Scientific Committee

| | |
|---|---|
| **Tetsuya Sumi** | **WRRC, DPRI, Kyoto University, Japan** |
| **Mathias Kondolf** | University of California Berkeley, USA |
| **Hirokazu Tatano** | GADRI, Kyoto University, Japan |
| **Anton Schleiss** | EPFL, Lausanne, Switzerland |
| **Toshio Koike** | ICHARM, PWRI, Japan |
| **Osman Abdalla** | Sultan Qaboos University, Oman |
| **Ichiro Fujita** | Kobe University, Japan |
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| **Mitsuteru Irie** | Miyazaki University, Japan |
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| **Mohamed Saber** | WRRC, DPRI, Kyoto University, Japan |
| **Taleb Odeh** | The Hashemite University, Jordan |
| **Mohammed Abdelfattah** | Military College, Oman |
| **Mohamed El- Manadely** | King Abdulaziz University, Saudi Arabia |
| **Ahmed Hadidi** | German University of Technology in Oman |
| **Marian Muste** | IIHR, University of IOWA, USA |
| **Reinhard Hinkelmann** | TU Berlin, Germany |
| **Aminuddin Ab Ghani** | REDAC, Universiti Sains, Malaysia |
| **Ekkehard Holzbecher** | German University of Technology, Oman |
| **Alastair G. Barnett** | Hydra Software, New Zealand |
| **Dalila Loudyi** | IAHR Council Member, Hassan II Univ. of Casablanca, Morocco |
| **Lefkir Abdelouhab** | Ecole Nationale Supérieur des Travaux Publics, Algeria |
| **Uwe Troeger** | Technische Universität Berlin, Germany |
| **Mohammed Amin Hafnaoui** | CRSTRA, Algeria |
| **Ahmed Sefelnasr** | Assiut University, Egypt |
| **Riadh Ata** | EDF, France |
| **Emad Habib** | University of Louisiana at Lafayette, USA |

## Symposium Agenda

| | Day | Time | Activity |
|---|---|---|---|
| 1 | **Tuesday 25th of February** | 9:00 – 16:00 | **Field Excursion** |
| 2 | Special seminar Day **Wednesday 26th of February** | 11:00 – 12:00 | ➢ Registration |
| | | 12:00 – 13:00 | ➢ Lunch |
| | | 13:00 – 13:25 | ➢ **Opening** |
| | | 13:25 – 14:55 | ➢ **Special Seminar Program – Part 1** |
| | | 14:55 – 15:10 | ➢ Coffee Break |
| | | 15:10 – 16:30 | ➢ **Special Seminar Program – Part 2** |
| | | 17:30 – 19:30 | ➢ Welcome Dinner |
| 3 | 1st day of ISFF2020 **Thursday 27th of February** | 9:00 – 10:00 | ➢ Registration |
| | | 10:00 – 10:55 | ➢ **Opening Session** |
| | | 11:00 – 11:10 | ➢ **Group Photo** |
| | | 11:10 – 11:25 | ➢ Coffee Break |
| | | 11:25 – 12:45 | ➢ Session 1: Flash Floods Challenges and Strategies |
| | | 12:45 – 13:30 | ➢ Lunch |
| | | 13:30 – 14:15 | ➢ **Poster Session A** |
| | | 14:15 – 15:15 | ➢ Session 2: Advances in Understanding Flood Modelling and Forecasting |
| | | 15:15 – 15:30 | ➢ Coffee Break |
| | | 15:30 – 16:30 | ➢ Session 3: Flash Flood Mitigation Measures and Warning Systems |

| Day | | Time | Activity |
|---|---|---|---|
| 4 | 2nd day of ISFF2020<br>**Friday**<br>**28th of February** | 9:00 – 9:30 | ➢ Registration |
| | | 9:30 – 10:30 | ➢ Session 4: Hydrometeorology and Climate Change |
| | | 10:30 – 10:45 | ➢ Coffee Break |
| | | 10:45 – 11:45 | ➢ Session 5: Reservoir Sedimentation and Sediment Yield |
| | | 11:45 – 12:30 | ➢ Lunch |
| | | 12:30 – 13:15 | ➢ **Poster Session B** |
| | | 13:15 – 14:15 | ➢ Session 6: Surface Runoff and Groundwater Management |
| | | 14:15 – 14:30 | ➢ Coffee Break |
| | | 14:30 – 15:30 | ➢ Session 7: Data Challenges: Monitoring, Analysis and Sharing |
| | | 15:30 – 15:45 | ➢ Coffee Break |
| | | 15:45 – 17:20 | ➢ **Closing Session, potential ISFF projects and roadmap** |
| | | 18:00 – 20:00 | ➢ **Dinner** |

# Detailed Program

## Field Excursion: 25th February 2020 (Tuesday)

***Excursion Visit:*** *Hiyoshi Dam and Arashiyama*

*Coordinated by* ***Dr. Tetsuya Sumi*** (Kyoto University, Japan)

| Time | Target Site |
|---|---|
| 9:00 | **Meeting place: HOTEL ELCIENT KYOTO** |
| 9:20 | Departure: One large bus<br>Expected numbers of participants (30-40) + Staffs |
| 10:30 | Arrival at Hiyoshi Dam Upstream of Katsura River |
| 12:00 – 13:00 | Lunch Break (Lunch box provided) |
| 13:00 | Departure |
| 14:00 | Arrival at Arashiyama |
| 15:00 | Departure from Arashiyama |
| 16:00 | Arrival at Hotel ELCIENT Kyoto |

## 26th February 2020 (Wednesday), at Seminar Room 4 & 5, Obaku Plaza

| | | |
|---|---|---|
| **11:00 – 12:00** | ***Registration*** | |
| 12:00 – 13:00 | ***Lunch Time (Lunch Box Provided)*** | |
| ***Special Seminar on Flash Floods Risk at UNESCO World Heritage Sites (WHS) – Opening*** *Chaired by:* ***Dr. Sameh Kantoush*** (Kyoto University, Japan) | | |
| 13:00 – 13:05 | Opening Remarks and Guests Welcome | ***Dr. Manabu Hashimoto, Director of DPRI*** (Kyoto University, Japan) |
| 13:05 – 13:15 | Opening Speech by the Jordanian Ambassador in Japan. | ***H.E. Lina Annab*** (Ambassador of Jordan in Japan) |
| 13:15 – 13:25 | UNESCO Flash Flood Project in the MENA Region (*General Introduction*) | ***Dr. Tetsuya Sumi*** (Kyoto University, Japan) |
| ***Special Seminar on Flash Floods Risk at UNESCO World Heritage Sites (WHS) – Part 1*** *Chaired by:* ***Dr. Sameh Kantoush*** (Kyoto University, Japan) | | |
| ***Note:*** *Allocated time for Oral Presentations: 20 min. talk + 10 min. discussion* | | |
| 13:25 – 13:55 | Flash-Flood Risk Prevention at the World Heritage Site of Petra from Preliminary Studies to Preventive Measures | ***Ms. Giorgia Cesaro*** **(**UNESCO Amman Office, Jordan) |
| 13:55 – 14:25 | Petra Authority Efforts to Reduce Flash Flood Risks | ***Dr. Hussein Alhassanat*** (PDTRA, Jordan) |
| 14:25 – 14:55 | Flash Floods Mitigation Measures at the UNESCO World Heritage of Petra, Jordan | ***Eng. Yoshihiro Motoki*** (Nippon Koei Co., Ltd., Japan) |
| 14:55 – 15:10 | ***Coffee Break*** **(Seminar Room 1 & 2)** | |
| ***Special Seminar on Flash Floods Risk at UNESCO World Heritage Sites (WHS) – Part 2*** *Chaired by:* ***Dr. Tetsuya Sumi*** (Kyoto University, Japan) | | |
| 15:10 – 15:40 | Flash Flood Modelling and Mitigation at the Valley of Kings | ***Dr. Sameh Kantoush*** (Kyoto University, Japan) |
| 15:40 – 16:10 | JICA Efforts for the Flood Disaster Risk Reduction in the world | ***Mr. Toshiro Suzuki*** (JICA Japan) |
| 16:10 – 16:40 | UNESCO-Japan Cooperation: Capacity Building for Managing Natural Disasters of Flash Floods: Way Forward Towards World Heritage Protection in the Arab Region | ***Dr. Abdelaziz Zaki*** (UNESCO Cairo Office, Egypt) |
| 17:30 – 19:30 | **Welcome Dinner** (Kyoto University Cafeteria) | |
| *Chaired by:* ***Dr. Sameh Kantoush*** (Kyoto University, Japan) | | |

# First Day of ISFF2020: 27th February 2020 (Thursday), at KIHADA Hall

| | | |
|---|---|---|
| ***09:00 – 10:00*** | ***Registration*** | |
| ***Opening Session:*** *Moderated by:* ***Dr. Shigenobu Tanaka*** (Kyoto University, Japan) | | |
| **Time** | **Title of presentation** | **Presenter** |
| 10:00 – 10:05 | DPRI Welcome Message | ***Dr. Manabu Hashimoto, Director of DPRI*** (Kyoto University, Japan) |
| 10:05 – 10:15 | Symposium Program, Statement and General Vision | ***Dr. Tetsuya Sumi*** (Kyoto University, Japan) |
| 10:15 – 10:25 | Flood Management in Japan | ***Dr. Murase Masahiko*** (International Affairs Office, Water and Disaster Management Bureau, MLIT, Japan) |
| 10:25 – 10:35 | JICA Efforts for the Flood Disaster Risk Reduction in the World | ***Mr. Toshiro Suzuki*** (JICA, Japan) |
| 10:35 – 10:45 | Egypt-Japan Education Partnership "EJEP" | ***Dr. Hany El-Shemy*** (Cultural Consular Japan and South Korea Office Manager, Embassy of Egypt) |
| 10:45 – 10:55 | Outcomes of the Special Seminar on Flash Floods Risk at UNESCO World Heritage Sites (WHS) | ***Dr. Sameh Kantoush*** (Kyoto University, Japan) |
| 11:00 – 11:10 | ***Group Photo at "KIHADA Hall"*** | |
| 11:10 – 11:25 | ***Coffee Break*** **(Hybrid Space)** | |

| ***Session 1: Flash Floods Challenges and Strategies***<br>*Chaired by:* ***Dr. Marwan Alraggad*** (INWRDAM, Jordan) | | |
|---|---|---|
| ***Note:*** *Allocated time for Oral Presentations: 13 min. talk + 7 min. discussion* | | |
| 11:25 – 11:45 | Flash Floods in Arid Zones: Lessons Learned from MENA Region | ***Dr. Dalila Loudyi*** (IAHR Council Member, Hassan II University of Casablanca, Morocco) |
| 11:45 – 12:05 | Flash Floods in the United Arab Emirates (UAE) | ***Dr. Ahmed Murad*** (United Arab Emirates University, United Arab Emirates) |
| 12:05 – 12:25 | Water Harvesting Small Scale Projects to Manage Flash Flood Hazard Due to Climate Change in Jordan | ***Eng. Abeer Sabha*** (Water harvesting directorate, Jordan Valley Authority, Ministry of Water and Irrigation, Jordan) |
| 12:25 – 12:45 | Flash Floods Challenges and Mitigation in Algeria | ***Dr. Boutaghane Hamouda*** (Badji Mokhtar - Annaba University, Algeria) |
| 12:45 – 13:30 | ***Lunch Time (Lunch Box Provided)*** | |

| ***Poster Session A***<br>*Chaired by:* ***Dr. Shigenobu Tanaka*** (Kyoto University, Japan) | |
|---|---|
| 13:30 – 14:15 | ***Poster Session A (3 min. for each poster)*** |
| | ***Best Poster Award for Students & Young Researchers (Scientific Committee)*** |

***Session 2: Advances in Understanding Flood Modelling and Forecasting***

*Chaired by:* ***Dr. Dalila Loudyi*** (IAHR Council Member, Hassan II Univ. of Casablanca, Morocco)

***Note:*** *Allocated time for Oral Presentations: 13 min. talk + 7 min. discussion*

| | | |
|---|---|---|
| 14:15 – 14:35 | Evaluation of the Flood Risk at the Medjerda River Using the HECRAS 2D Model | ***Dr. Jalel Aouissi*** (Carthage University, Tunisia) |
| 14:35 – 14:55 | On Watershed Delineation for Flood Modelling in Lowlands | ***Dr. Ekkehard Holzbecher*** (GUtech, Oman) |
| 14:55 – 15:15 | Rainfall-Runoff Modelling with a Deep Learning Neural Network Model | ***Dr. Tayeb Boulmaiz*** (Ghardaia University, Algeria) |
| 15:15 – 15:30 | ***Coffee Break*** **(Hybrid Space)** | |

***Session 3: Flash Flood Mitigation Measures and Warning Systems***

*Chaired by:* ***Dr. Mohammed Abdelfattah*** (Military Technological College, Oman)

***Note:*** *Allocated time for Oral Presentations: 13 min. talk + 7 min. discussion*

| | | |
|---|---|---|
| 15:30 – 15:50 | Flash Flood Mapping in Jordan | ***Dr. Marwan Alraggad*** (INWRDAM, Jordan) |
| 15:50 – 16:10 | Flash Floods Road Mapping: The Egyptian Experience | ***Dr. Dia El Din El Quosy*** (The National Water Research Center, Egypt) |
| 16:10 – 16:30 | Causes and Consequences of Flash Flood in (Saqr Park Area, United Arab Emirates (UAE) | ***Dr. Saber Hussein*** (United Arab Emirates University, United Arab Emirates). |

# 2nd Day of ISFF2020: 28th February 2020 (Friday) at KIHADA Hall

| | | |
|---|---|---|
| ***09:00 – 09:30*** | ***Registration*** | |
| ***Session 4: Hydrometeorology and Climate Change*** | | |
| | *Chaired by:* ***Dr. Kenji Tanaka*** (Kyoto University, Japan) | |
| ***Note:*** *Allocated time for Oral Presentations: 13 min. talk + 7 min. discussion* | | |
| 9:30 – 9:50 | Assessing The Impacts of Tropical Cyclone Hazards at Local-Scales by Dynamical Downscaling Experiments | ***Dr. Tetsuya Takemi*** (Kyoto University, Japan) |
| 9:50 – 10:10 | Implementation of Hydrological and Hydraulic Models to Forecast River Flood Risks and Proposition Of Management Measures. Case Study of Nyabugogo River Basin In Rwanda | ***Dr. Chérifa Abdelbaki*** (PAUWES, Algeria) |
| 10:10 – 10:30 | Long-Term Trend Analysis and Variability of Annual and Seasonal Precipitation over the MENA Region | ***Dr. Mohamed Saber*** (Kyoto University, Japan) |
| 10:30 – 10:45 | ***Coffee Break*** **(Hybrid Space)** | |

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|---|---|---|
| ***Session 5: Reservoir Sedimentation and Sediment Yield*** | | |
| | *Chaired by:* ***Dr. Mitsuteru Irie*** (University of Miyazaki, Japan) | |
| ***Note:*** *Allocated time for Oral Presentations: 13 min. talk + 7 min. discussion* | | |
| 10:45 – 11:05 | Beach Erosion and Wadi Sediment Supply along Al Batinah Coast, Oman | ***Dr. Hitoshi Tanaka*** (Tohoku University). |
| 11:05 – 11:25 | Estimation of Sediment Yield in Arid Wadis Using Remote Sensing and GIS | ***Dr. Ashraf M. Elmoustafa (***Ain Shams University, Egypt) |
| 11:25 – 11:45 | Reservoir Sediment Management Practice in Sudan: Case Study of Keg Dam | ***Dr. Elhadi Adam*** (Ministry of Irrigation and Water resources, Sudan) |
| 11:45 – 12:30 | ***Lunch Time (Lunch Box Provided)*** | |

***Poster Session B***

*Chaired by:* ***Dr. Shigenobu Tanaka*** (Kyoto University, Japan)

| | | |
|---|---|---|
| 12:30 – 13:15 | ***Poster Session B (3 min. for each poster)*** | |
| | ***Best Poster Award for Students & Young Researchers (Scientific Committee)*** | |

***Session 6: Surface Runoff and Groundwater Management***

*Chaired by:* ***Dr. Hitoshi Tanaka (Tohoku University)***

***Note:*** *Allocated time for Oral Presentations: 13 min. talk + 7 min. discussion*

| | | |
|---|---|---|
| 13:15 – 13:35 | Interplay Between Seasonal Surface Runoff and Groundwater in Jaww Plain UAE | ***Dr. Ahmed Murad*** (United Arab Emirates University, United Arab Emirates) |
| 13:35 – 13:55 | A Nominal Model Upper Bounding Flash Flood Events in a Wadi of the Jordan Rift Valley | ***Dr. Koichi Unami*** (Kyoto University, Japan) |
| 13:55 – 14:15 | Analytic Hierarchical Process in Selecting Artificial Neutral Networks for Suspended Sediment Load Modelling | ***Dr. Abdelouahab Lefkir*** (École Nationale Polytechnique (ENP), Algeria) |
| 14:15 – 14:30 | ***Coffee Break*** **(Hybrid Space)** | |

***Session 7:*** **Data Challenges: Monitoring, Analysis, and Sharing**

*Chaired by:* ***Dr. Tomoharu Hori*** **(**Kyoto University, Japan)

***Note:*** *Allocated time for Oral Presentations: 13 min. talk + 7 min. discussion*

| | | |
|---|---|---|
| 14:30 – 14:50 | Application of Image Identification by Artificial Intelligence to Aerial Pictures Taken from UAV for Channel Management | ***Dr. Mitsuteru Irie*** (University of Miyazaki, Japan) |
| 14:50 – 15:10 | Analysis and Consequences of the Flash Floods in Nabeul Area | ***Dr. Jamila Tarhouni*** (Institut National Agronomique de Tunisie (INAT), Tunisia) |
| 15:10 – 15:30 | Flood Hazard Mapping for Arid Basins in the Eastern Desert, Egypt | ***Dr. Mohamed Abdelfattah*** (Military Technological College, Oman) |
| 15:30 – 15:45 | ***Coffee Break*** **(Hybrid Space)** | |

| | | |
|---|---|---|
| ***Closing Session: Potential ISFF Projects and Roadmap*** *Moderated by:* ***Dr. Tetsuya Sumi*** (Kyoto University, Japan) | | |
| 15:45 – 15:55 | Roadmap of ISFF | ***Dr. Sameh Kantoush*** (Kyoto University, Japan) |
| 15:55 – 16:05 | ISFF Transboundary Project: Integrated Wadi Medjerda Watershed Management Project | ***Dr. Boutaghane Hamouda*** (Badji Mokhtar - Annaba University, Algeria) |
| 16:05 – 16:15 | ISFF Networking for Better Flood Monitoring: JSPS Core-to-Core Project | ***Dr. Dalila Loudyi*** (IAHR Council Member, Hassan II University of Casablanca, Morocco) |
| 16:15 – 16:25 | ISFF UNESCO Project: Flash Flood Risk of UNESCO-WHS | ***Dr. Abdelaziz Zaki*** (UNESCO, Cairo Office) |
| 16:25 – 16:35 | Educational Project for Flash Floods Resilience | ***Dr. Mohamed Saber*** (Kyoto University, Japan) |
| 16:35 – 17:00 | Plenary Discussion for Future Research Collaboration | ***All Participants*** |
| 17:00 – 17:10 | Announcement of Best Posters Winners | ***Dr. Shigenobu Tanaka*** (Kyoto University, Japan) |
| 17:10 – 17:20 | The 6th ISFF Talk | ***Dr. Marwan Alraggad*** (INWRDAM, Jordan) |
| **18:00 – 20:00 Dinner** (Kyoto University Restaurant) *Chaired by* ***Dr. Daisuke Nohara*** (Kyoto University, Japan) | | |

# Poster Program – Session A

| First Author | Title | Poster Code | Status |
|---|---|---|---|
| **Dina Elleithy** (Kyoto University) | Change in bed soil characteristics and flood potential in response to sediment transport and flood mitigation structures | SA-1 | PhD Student |
| **Hadir Abd-El Moneim** (Alexandria University) | Statistical evaluation of high-resolution precipitation products in a hydrological modelling of eastern Nile basin | SA-2 | Master Student |
| **Leila Djellit** (Badji Mokhtar University) | Study on the impact of climate change in the Medjerda watershed, Algeria | SA-3 | Master Student |
| **Omar Habiba** (Kyoto University) | Flash flood modelling and mitigation at the archaeological site of Petra, Jordan | SA-4 | Researcher |
| **Richard Martin E. Rinen** (Kyoto University) | Mapping flood control projects: an (historical) overview of flood control projects in the Philippines. | SA-5 | PhD Student |
| **Sabah Almahrouqi** (Kyoto University) | Analysis of variability and trends of extreme rainfall events over Arab region for the period 1983-2019 | SA-6 | Master Student |
| **Ibrahim Al-Odaini** (Sana'a university) | Flash flood prevention and mitigation options for heritage city of Sana'a due to the impact of climate changes | SA-7 | Master Student |
| **Ramy Abdel Hafez** (Toshka Trading & Contracting Company) | Implementation of the trapezoid-shaped CSG dam at wadi Abadi, Egypt | SA-8 | Engineer |
| **Ahmed Fekri** (University Hassan II of Casablanca) | Floods in Morocco: overview and evaluation by the swot method | SA-9 | Professor |
| **Saroj Karki** (Kyoto University) | Modelling the impact of river bed aggradation on the inundation scenario in an ungauged ephemeral stream using hydrological and 2d hydrodynamic model: a case of Bakra river basin, Nepal | SA-10 | Researcher |
| **Douglas Ferreira Nogueira** (Uppsala University) | Mobile-Based Early Warning Systems in Mozambique. An exploratory study on the viability to integrate Cell Broadcast into disaster mitigation routines. | SA-11 | Master Student |
| **Sridhara Nayak** (Kyoto University) | Future Changes In The Rainfall Characteristics Over India In MRI-AGCM Global Warming Experiments | SA-12 | Researcher |

# Poster Program – Session B

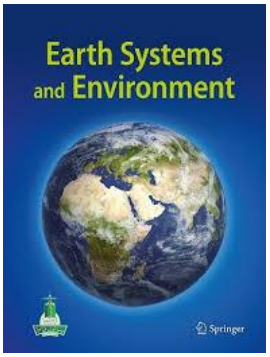
| First Author | Title | Poster Code | Status |
|---|---|---|---|
| **Tahani Al-Harrasi** (Kyoto University) | Assessment of sedimentation using field investigation and uav imaging at asserin upstream dam, wadi Mijlass, Oman | SB-1 | Master Student |
| **Aline Uwineza** (Miyazaki University) | Rainwater harvesting, a solution to floods in Kigali | SB-2 | Master Student |
| **Mahmood Almamari** (Kyoto University) | Photogrammetry analysis approach to quantifying the post-flood peak discharge in the arid region, case study in Sultanate of Oman | SB-3 | Master Student |
| **Mir Mohammad Mones Hossaini** (Miyazaki University) | Strategic environmental assessment protocol for better flood management planning in Kabul basin | SB-4 | Master Student |
| **Karim Abdrabo** (Kyoto University) | Impacts of urban growth, extreme climate and disasters mismanagement on flash flood vulnerability in Egypt | SB-5 | Ph.D Student |
| **Rocky Talchabhadel** (Kyoto University) | Rainfall-runoff-inundation in a data-scarce flashy watershed: an application in Kandra river basin, Nepal | SB-6 | Researcher |
| **Boutaghane Hamouda** (Badji Mokhtar - Annaba University) | Spatial and temporal variability of extreme rainfall indices in north-east of Algeria | SB-7 | Professor |
| **Hassan Ayad** (Hassan II University of Casablanca) | Risk of coastal flood on the Atlantic sea, Morocco | SB-8 | Professor |
| **Khalid Alzeidi** (Military Technological College) | Investigation of sluice gates in energy dissipation through hydraulic jumps | SB-9 | Master Student |
| **Mouhanned Jabberi** (National agronomic institute of Tunisia) | Innovative strategies for integrated river basin management and reservoir sedimentation in Tunisia: case study of Sidi Salem Dam | SB-10 | Engineer |
| **Dahak Asma (Boutaghane Hamouda)** (Badji Mokhtar - Annaba University) | Experimental study for infiltration model choice: case of Madjez Ressoul catchment. | SB-11 | Master Student |
| **Nada Joumar** (Hassan II University of Casablanca) | Flood risk management in the N'fis watershed of the high Atlas-Morocco : hydrologic and statistical modelling for flood frequency analysis | SB-12 | Ph.D Student |

# Publications: Call for Papers

Wadi flash floods (WFFs) in arid and semi-arid regions has recently become more frequent and devastating resulting in great property damage and extensive loss of life as well as environment degradation. Lack of data (availability, quality), disasters (flash floods and drought), water scarcity (quantity and quality), missing of management (water and sediment), and poor knowledge and approaches (models, strategies, and planning) are the main challenges in arid and semi-arid regions. Therefore, a series of the International Symposium on Flash Floods in Wadi Systems (ISFF) were held in Japan (1st ISFF), Egypt (2nd ISFF), Oman (3rd ISFF), and Morocco (4th ISFF). The 5th ISFF will be held in Japan in Kyoto February 2020. The main objectives of ISFF are: 1) to form a platform for networking and sharing experiences and data among some MENA countries, scientists and authorities, 2) to stimulate cooperation among researchers in fundamental and applied sciences towards WFF research, 3) to develop new creative ideas and projects to adapt and mitigate wadi flash floods.

We are pleased to announce that the call of paper submission is open now:

## 1. Special issue (ISFF) at Earth Systems and Environment Journal




Disaster Risk Reduction and Assessment for the Flood Prone Urbanized and Heritage Sites in Arid and Semi-Arid Environments

**For Submission**:

**https://www.springer.com/journal/41748/updates/17551576**

## 2. Springer Book: Wadi Flash Floods

Challenges and Advanced Approaches for Disaster Risk Reduction and Water Harvesting in Arid and Semi-Arid Regions

**For Submission, send your paper to:**
sumi.tetsuya.2s@kyoto-u.ac.jp
kantoush.samehahmed.2n@kyoto-u.ac.jp
mohamedmd.saber.3u@kyoto-u.ac.jp

Springer

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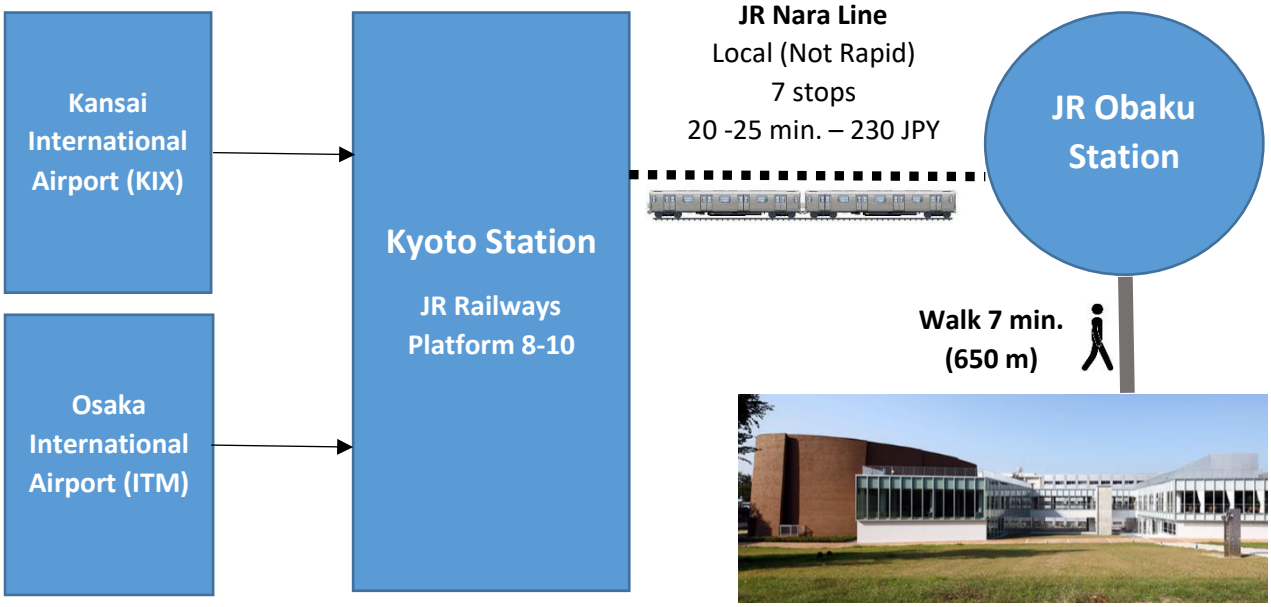


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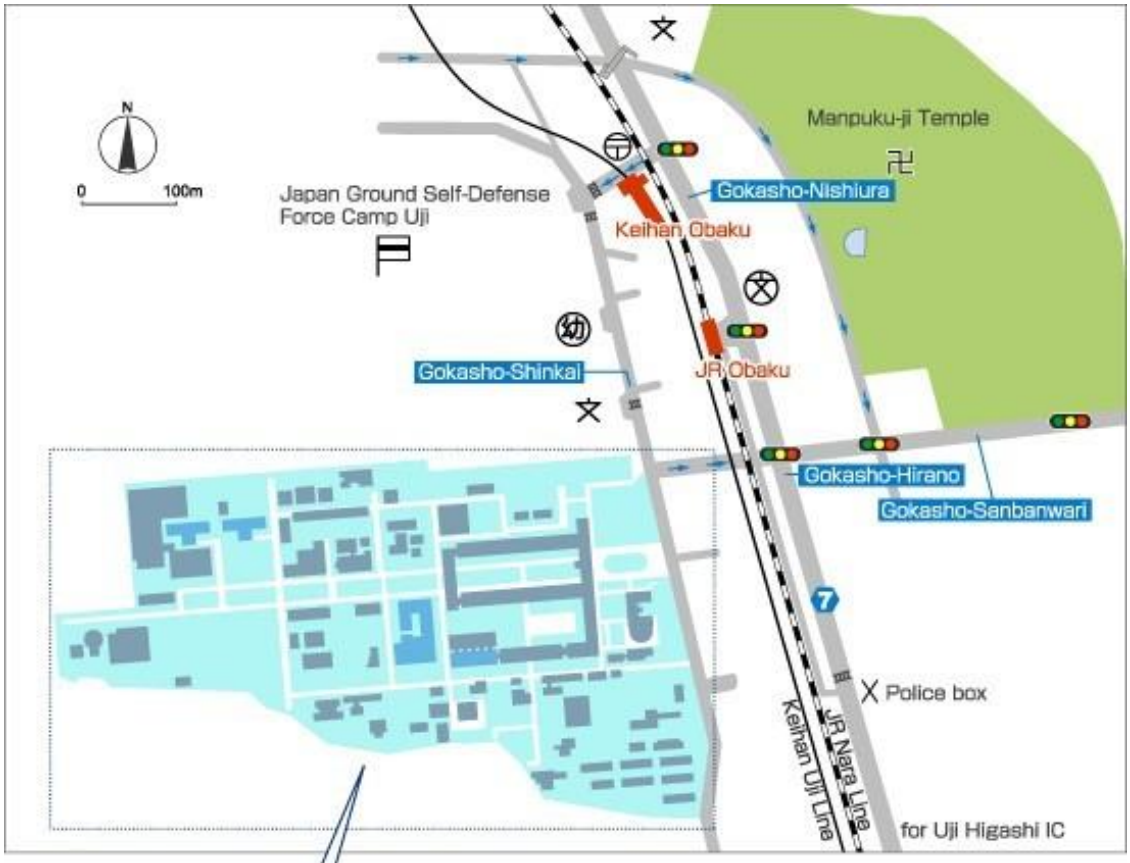
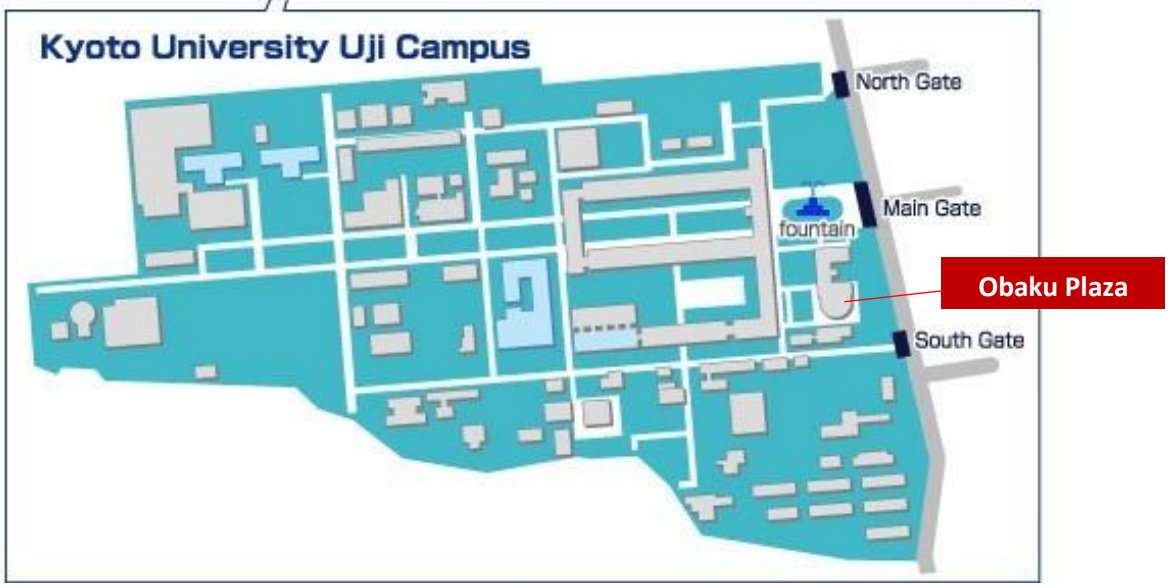
Map of the Location



# Abstracts

# Abstracts - Oral

# *UNESCO FLASH FLOOD PROJECT IN THE MENA REGION*

TETSUYA SUMI

*Water Resources Research Centre, Disaster Prevention Research Institute, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan*

**ABSTRACT**

Recently, extreme and frequent wadi flash floods have occurred in most of MENA arid zone, resulting in significant economic and property loses. For instance, flash floods hit Egypt, Jordan, and Saudi Arabia, 39 times over the period of 1900–2016 causing life losses of 1,508 and significant damages exceeding 1.8 billion US dollars. In 2018, Wadi flooding trapped and forced 3,000 tourists to evacuate to safe places 1 hour before the flood peak reached to the historic site of Petra, Jordan. Local people announced to the tourist by his loud voice 'Up, Up, Up' and sirens blared minutes before extreme flash flood after heavy rainfall approached the Petra. They were miraculously saved by a close call. The fatal flash flood struck Petra in 1963 when 22 French tourists and a local guide were killed by rapidly rising waters. The flash flood on 25 Oct. 2018, which happened at Wadi Zarqa-Maeen near Dead Sea area caused 21 deaths including 16 school children.

Within the framework of the UNESCO WHS, we have selected Petra in Jordan and Valley of King in Egypt as two potential sites for investigations. A group of researchers of Kyoto University in collaboration with Nippon Koei company conducted a preparatory field surveys and meetings for facts findings, and proposed cooperative research project. Three field surveys in Jordan have been conducted as the 1$^{st}$ survey on 3-9 August, 2$^{nd}$ survey 24-28 August and the 3$^{rd}$ 24-27 October, 2019.

Flash flood analysis model was developed and calibrated for Petra basin using the Rainfall-Runoff-Inundation (RRI) model. The calibration and the validation procedures have been done based on observed data in the region collected from published paper and Petra authority. Moreover, the model was applied to different recent flash flood events using Satellite. Furthermore, a synthetic rainfall analysis was applied on the calibrated model to estimate the scenarios of different extreme events and to understand the physical behaviour of the catchment. Moreover, the model is going to be used to estimate the behaviour of several events with different return periods. Subsequently, potential mitigation measures have been proposed and analysed using the calibrated model.

The single management strategy is not enough to reduce the flash flood risk; nevertheless, a combination of flood risk management approaches is required in the Wadi system. The proposed management approach focuses on developing a strategic methodology for evaluating wadi flash flood magnitudes, mitigation measures and floodwater harvesting. The lack of complete information archive of pre and post WFF events across the Petra obstruct the efforts to mitigate the flooding risks. There is a need to upgrade the installed rainfall and water level monitoring stations by PDTRA. Moreover, various existing infrastructures (culverts, bridges, canals, etc.) are required to be urgently improved through restoration, removal and reconstruction. There is an urgent need to mitigate and utilize floodwater as a new supply to sustain a minimum water resources base in rural desert areas.

**KEYWORDS:** Flash Floods; UNESCO-WHS; Rainfall-Runoff-Inundation; MENA; Hydrological Modelling

# *FLASH-FLOOD RISK PREVENTION AT THE WORLD HERITAGE SITE OF PETRA FROM PRELIMINARY STUDIES TO PREVENTIVE MEASURES*

SHATANAWI K.[A], CESARO G.[B], GIAMPORCARO R.[B]

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*b UNESCO Amman Office, 9 Ya'acoub Ammari Street (Abdoun), Amman, Jordan*

**ABSTRACT**

Petra is exposed to a number of hydro-geological hazards including flash floods, landslides and earthquakes, which have been increasingly impacting the site over the last centuries. Flash floods are recurrent events that occur during winter and spring time. They are generated by storm water runoff flowing into the Petra Archaeological Park Flash floods have been affecting the site since ancient times. The Nabataeans, its illustrious ancient inhabitants, had created an ingenious water management system to collect precious water for everyday uses and simultaneously mitigate the dangerous effects of flash flood in the site.

After the Nabatean times, those systems have been progressively deteriorating and no longer protect the site nor the visitors. During the rainy season extreme events, water flows into the 'Siq', a 1.2 km long canyon representing the main entrance for visitors to the site, from the surrounding channels (*wadis*) together with debris and rock fragments. This generates exceptional flash flooding events, which have caused several casualties and even some fatalities in the past.

Over recent years, flash floods have been increasingly affecting the site, also due to climate change phenomena and urban expansion in the site neighbouring areas. In November 2018, a major flooding event impacted on the site and the visitors, raising awareness on the need to take urgent actions to mitigate this phenomenon.

Since 2009, the UNESCO Amman Office has been supporting the Petra Development and Tourism Region Authority and the Department of Antiquities of Jordan in identifying an integrated and sustainable approach to manage natural hazards, thus contributing to ensuring tourist and monument safety. As part of this integrated framework, from September 2018 the UNESCO office in Amman started the implementation of a project funded through the Heritage Emergency Fund at the World Heritage Centre to support the Petra Development and Tourism Region Authority in developing preliminary designs for flash flood risk mitigation interventions at the site.

Within this framework, an integrated hydrologic-hydraulic model grounded on extensive topographic, hydrological and hydrographic studies of the Wadi Musa catchment area (approx. 60 km2) was produced to define the flood plain and identify high hazard locations within the Petra Archaeological Park. As a final output of the study and design process, a number of structural solutions have been proposed by taking into consideration the compatibility with the specific characteristics and values of Petra as a World Heritage Site. A number of non-structural measures have been also included so to apply a sustainable approach to the protection of the site, by taking into account specific land use regulations and view shed areas.

The present paper will outline the process followed by UNESCO over the past years to mitigate natural hazards at the site by focusing on the integrated approach adopted and the preliminary outcomes achieved in the prevention of flash flood hazards.

**KEYWORDS:** Petra; Jordan; Flash Floods: UNESCO-WHS; Extreme Events; Tourism; DRR

# *PETRA AUTHORITY EFFORTS TO REDUCE FLASH FLOOD RISKS*

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**ABSTRACT**

The frequent occurrence of natural disasters; especially flash floods, are resulting the significant threats to many countries around the world. The truth that cannot be ignored, is that the effects of flash floods on the developing countries' societies and economies are massive, compared with developed countries. Petra region; which is located in southern part of Jordan, is exposed to flash flood risks. Petra Region's communities have experienced the impacts of flash floods in recent years which led to losses in lives, public and private properties. These losses are due to lack of flash flood risk mitigation measures and the lack of knowledge among communities about flash flood risks. While the frequencies and impacts of flash floods might not be controlled easily, the need for more effective efforts has become extremely important. Accordingly, Petra Development and Tourism Region Authority has adopted my mitigation measures to reduce flash flood impacts such as; Early warning system, small-scaled terraces, rehabilitation of Nabatean water systems, hydrological specialized studies for mid-scaled dams, rainfall water drainage systems.

The researchers recommended the previous-mentioned projects to empower the local governmental institutions to mitigate flash flood impacts and enhance the resilience in Petra Region.

**KEYWORDS**: Floods; Disaster Risk; Mitigation; Early Warning System

# *FLASH FLOOD MITIGATION MEASURES AT THE UNESCO WORLD HERITAGE SITE OF PETRA, JORDAN*

YOSHIHIRO MOTOKI[1], OMAR HABIBA[2], MOHAMED SABER[2], SAMEH KANTOUSH[2], TETSUYA SUMI[2]

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**ABSTRACT**

Wadi flash floods in the Middle-East-North-Africa (MENA) region are considered as one of the most catastrophic phenomena possessing hazardous threat to the coastal cities and infrastructures, and human lives as well as the UNESCO World Heritage Sites (WHS). As it was seen in November 2018 and April 1963 in the UNESCO WHS Petra in Jordan, flash floods pose a serious threat to the lives of the tourists and the locals living there as well as the monuments themselves. Despite the advanced technology that exist nowadays, there is an obvious lack of mitigation measures in Wadi Mousa, where Petra is located in, such as flood water retention and check dams, diversion channels and terracings, etc. This study aims to develop and come up with the practical flash flood mitigation measures that will be applicable at Wadi Mousa to reduce the flash flood risks on the lives of tourists/ local residents as well as the monuments at Petra and infrastructure. The mitigation measures are going to be based on the results of hydrological and hydraulic analyses by means of the 2-dimensional rainfall-runoff-inundation (RRI) model and others. The RRI model was adapted to simulate different flood events and to estimate their impacts on flood peakflow, inundation and runoff volumes. Several field surveys have already been conducted and some candidate sites for mitigation measures such as dams were confirmed based on the geomorphological features as well as inundation areas and the hydrological conditions. Using the hydrological model, effect of dams as well as other mitigation measures such as diversion channels, terracings and afforestation, etc. are going to be assessed in the hydrological model. The various simulations are going to be represented considering also the dams operations as well as their locations and their numbers. The scenarios will consider 6 various return periods of flood events (5, 10, 20, 50, 100, and 200 years of return periods). Moreover, the results of mitigation measures impacts on flood peakflow and volume as well as the inundation area are going to be evaluated. Moreover, the capacity of the diversion tunnel is taken into account in combination with dams and retention facilities at upstream in terms of the reduction of flood peak discharge. Due to climate change, the risk of flash flood is increasing, especially in the MENA (North Africa and Middle East) region. Therefore, the study is a way forward to promote the awareness as well as to propose effective flash flood mitigation measures in the that region.

**KEYWORDS:** Hydrology; Flood Mitigation Measures; Flood Risk; Petra; Wadi Mousa; UNESCO World Heritage Sites; Flash Flood.

# *FLASH FLOOD MODELLING AND MITIGATION AT THE VALLEY OF KINGS*

SAMEH KANTOUSH[1], TETSUYA SUMI[1], YUSUKE OGISO[1], MOHAMED SABER[1], MOHAMED ABDEL-FATTAH[2], TETSUYA SUMI[1]

[1] *Water Resources Research Centre, Disaster Prevention Research Institute, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan*
[1] *Water*
[2] *Military Technological College, Oman*

**ABSTRACT**

Flash floods affect various archaeological sites in Egypt unavoidably specially with the increase of the frequency and the severity of the extreme events. The Valley of the Kings in Egypt is a UNESCO World Heritage Site with more than thirty opened tombs. Recently, most of these tombs have been damaged and inundated due to the 1994 flood. Therefore, such mitigation strategy has already been proposed and implementation with low protection wall surrounding tombs. The main focus in the conducted study focused on the evaluation and risk assessment of the current mitigation measures especially under such extreme flood events. Two-Dimensional hydrodynamic model combined with rainfall runoff modelling by using TELEMAC-ED to simulate the present situation without protection and determine the risk of the 1994 extreme event. The results revealed that the current mitigation measures are not efficient. Based on the simulation scenarios, risk of flash floods is assessed, and more efficient mitigation measures are proposed.

Regarding the risk assessment of the Valley of the Kings, the flood risk of each tomb in the Archaeological site were revealed. It confirmed whether important tombs with historical and economic value were flooded. 59 percent of the while tomb was flooded and the 2 tombs (Tutankhamun and Ramses VI) which should be most protected were flooded in the simulation of the storm of 100 year return period. Therefore the current measures are not efficient as mentioned above. Hence, the two following measures were proposed: (1) to rise the walls by 50 cm. (2) to fill depressions by reshaping bathymetry.

In conclusion, the results of the simulation in the study showed that the flood damage was reduced by about ten percent and important tombs were protected.

**KEYWORDS**: Flash Floods; the Valley of the Kings; TELEMAC-2D; Mitigation Measures

# *JICA EFFORTS FOR THE DISASTER RISK REDUCTION OF FLASH FLOODS*

TOSHIRO SUZUKI

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**ABSTRACT**

Japan International Cooperation Agency (JICA) is supporting development projects in other countries through bilateral cooperation, and is currently supporting human resource development and tourism development in Jordan.

JICA's support areas covers urban and regional development, transportation, information and communications, education, water resources, etc. Flood disaster risk reduction is also one of the issues to be supported.

In this presentation, support schemes at the stage of project finding, formulation and implementation will be introduced with examples.

**KEYWORDS:** Japan; Project; Support; Public; Mitigation; Implementation

# *UNESCO-JAPAN COOPERATION: CAPACITY BUILDING FOR MANAGING NATURAL DISASTERS OF FLASH FLOODS: WAY FORWARD TOWARDS WORLD HERITAGE PROTECTION IN THE ARAB REGION*

ABDELAZIZ ZAKI; GHAITH FARIZ

*UNESCO Cairo Office, Egypt*
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**ABSTRACT**

Within the framework of UNESCO-Japan Fund-In-Trust Cooperation, the Japanese Government supported the project entitled: Urgent Capacity Development for Managing Natural Disaster Risks of Flash Floods in Egypt, Jordan, Sudan and Yemen (2015- 2016). The overall objective of the project was to reduce the economic losses and fatalities resulting from these flash floods through building national and regional capacities for early warning effective emergency responses. The project produced a repository of best practices of flash floods risk management through the study of a pilot hotspot in each of the four countries, replicable and expandable at the national and regional levels. The project successfully developed the capacity for Managing Natural Disaster Risks of Flash Floods to: evaluate current status of Flash Flood Risk, develop Risk Management Plans; and enhance participatory approach in managing Flash Flood Risk with involvement of local communities. The project included a community awareness program to disseminate the technical outputs of the project at community level to reduce the vulnerability of the local communities to manage the natural disasters of flash flood risks as an example of science-community interface. Within the campaigns, active and target groups at local level were identified to ensure long terms monitoring and sustainability of the community engagement and action regarding the anticipated flood cycle and impacts. The technical and financial contribution of the Government of Japan was highlighted. at the international level, the project achieved good visibility by sharing the project outputs in high regional panels events: such as the Expert Group Meeting on Coordinating Responses to Climate Change and Disaster Risk Reduction in the Arab Region (UN-House, Beirut, 19-20 December 2017). The involvement of ICHARM and Kyoto Universities in the project activities was highly acknowledged at national, regional and international levels. On the other hand, the Arab Region has a diverse and rich natural heritage ranging from archaeological prehistoric sites, to Rock art sites, to ancient Greek sites, to Roman sites. Many of these sites might be endangered by flash floods natural disasters. Based on the JFIT project achievements, this presentation outlines the possible joint interventions for protecting world heritage sites (WHS) in the Arab region with special focus on promoting the concept of flash flood risk management with the involvement of all stakeholders including local authorities, community groups, private sectors. Moreover, the presentation will shade light on main perspective of integrated protection framework of WHS based on socio-economic-environmental dimensions taking into account heritage preservation constraints as stressed by UNESCO.

**KEYWORDS:** Flash Floods; Arab Region; World Heritage Site

# *FLASH FLOODS IN ARID ZONES: LESSONS LEARNED FROM MENA REGION*

DALILA LOUDYI

*IAHR Council member for MENA/India sub-continent region*

**ABSTRACT**

The paradoxical situation of flash floods taking place in arid zones is often confusing and its resulting physical damages is even more exacerbated by its unexpected and incomprehensible occurrence in such areas. Indeed, many desert zones have experienced in the last ten years uncommon flash floods. The contrast is such that in some locations, people welcome these hazards despite their dramatic consequences as they are thought to bring water and wealth in the cultural general belief of the desert population (Saudi Arabia, Morocco, Algeria, etc.). In fact, climate change and other anthropogenic factors have generated such phenomena. The emergence of these new situations is even worsened by the lack of historical data that describe similar cases and can help in the prediction and mitigation of prospective flood events in such areas.

In this work, a comparison between flood event in arid and humid zones is given. The specific features of these situations in the MENA region is analyzed based on reported extent and damages. The nature of these floods is particularly described with regard to hydrological and meteorological data availability. Vulnerability of such regions is also a specific issue as urbanization and land use rules are often ignoring flood risks. Therefore, resulting flood damages are evaluated depending on specific regional criteria related to human, environmental and material components. Moreover, modeling approaches that are used in the conditions of wet and dry areas are examined and ways for improving the accuracy of flash flood modeling works in arid zones are suggested. The use of structural solutions such as dams is often used in arid countries, especially in MENA region, however their efficiency and long term performance has to be assessed. The path to new reliable flood defense solutions is searched in a way that can be a response to water scarcity challenge in the MENA region.

**KEYWORDS:** Flash Floods; MENA Region; Climate Change; Mitigation; Vulnerability.

# *FLASH FLOODS IN THE UNITED ARAB EMIRATES (UAE)*

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**ABSTRACT**

Flash flood is a common phenomenon in arid regions where heavy torrential rainfall may continue for a few hours and results in flooding of the lowlands. The intensity and extent of flash floods may also depend on the topography and geology of the affected areas. Flash flooding in the United Arab Emirates (UAE) commonly occurs in the East and North East regions that have relatively high elevation (> 200 m asl) and in particular regions neighbouring the mountainous drainage catchments. The extent of the flash flood can vary from small (50 m wide) surface runoff channels to a few km wide alluvial plan. In addition to the size of the drainage basin, the intensity of flash flood may be more in the outwash valleys draining igneous and metamorphic outcrops than those of carbonate and quaternary alluviums. In most cases, sand dune fields suffer little or no flash flood features most likely due to their high permeability and location at areas further away from the catchments. The correlation between geological conditions and flash floods suggest that high permeability conditions may reduce the effect of surface runoff and thereby occurrence of flash flooding. Different types of dams were constructed at outflow valleys to mitigate the effects of flash flooding in the UAE. Water in these dams is used for agriculture and recharge of groundwater.

**KEYWORDS:** Flash Flood; Arid Climate; Rainfall; UAE

# *WATER HARVESTING SMALL SCALE PROJECTS TO MANAGE FLASH FLOOD HAZARD DUE TO CLIMATE CHANGE IN JORDAN*

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**ABSTRACT**

This study address the critical situation of the Jordanians water resources ,based on the Climate trends analyses using downscaled climatic models obtained from CORDEX under different RCPs, the main climate challenges that the water sector faces in Jordan are temperature increase, precipitation decrease, increase drought phenomenon, and increase in potential evapotranspiration .Thus, the subjected climate sensitivity indicators in water sector were determined as reduced groundwater recharge, groundwater quality deterioration, surface flow reduction, and increased water demand. According to Jordan's Third National Communication on Climate Change, the climate change vulnerability assessment indicated sever (high) vulnerability of the water sector (i.e. sensitivity level of about 3.71 / 5).

Indeed the current situation in Jordan featuring many challenges regarding floods management for example, but not limited,(1) Flood monitoring stations on major valleys in various surface basins are mostly off and in need of maintenance Periodic follow-up and protection from aggression, and the possibility of linking them electronically to the control center and crisis management center,(2) Lack of automation of climatic data on precipitation intensity and quantity and lack of data when needed ,(3) The number of wadis in the Kingdom is very large and the number of secondary falls as well and most of them can cause floods, especially at the beginning of the Rainy season and strong atmospheric instability especially in the side and southern valleys ,(4) Large amounts of rain resulting from sudden and large rainfall in the surface basins in general need for a detailed study of the utilization of that water in feeding the aquifers,(5) The presence of landslide areas along the mountain ranges from the north of the Kingdom to the south, and intersect those Glides with main and secondary valley ducts, ( 6)There are many studies on the prevention of floods and that lack of funding in addition to the need for further investigation and update previous studies.

The key objective for this study was to investigate and develop and sustain new water sources in wadis with relatively high rain fall, as well as flood management, one of the proposed project wadi Al Nukheila dam located upstream of Existing Mujib Dam some 15 km South East of Mujib Dam some 90 km from Amman to the south East within Mujib Basin with rainfall around 250 mm/ year and the wadi Al Nukheila is subject to yearly floods accumulated at Mujib Dam with design capacity about 30-million-meter cube, the Mujib Dam usually subject to foods since the completion date on 2003, whereby the water spills dawn stream to Dead See. Mujib Dam water used for industrial at the east shore of dead see and supply drinking water to the north of Karak since 2014 and also used for small scale irrigation, another proposed project is Installation of

Hydrometric Station in Wadi Yutum in order to protect the northern parts of Aqaba are the most vulnerable regions for flash flood hazards since they are located downstream from areas of major .In addition to the (a/m) proposed projects there are many studies conducted by MWI and attached herewith.

The main results indicate:

- The necessity of the Early Warning Systems (EWS) in Wadi Yutum.

- The need for a specialized team working on the preparation of the database, whereas scientific basis of good early warning systems is the data availability on the hazards and the primary objective of a warning system is to empower and enhance the technical capabilities of the institutes that collect, store and manage the related data. Information that is most vital in the design of an early warning system consists of the full suite of meteorological data and products, including measurements and early forecasting extreme events, that will enable the potential natural hazard to be accurately characterized within enough period of time and the necessary decisions on sitting, construction, protection and precaution to be taken on a fully informed basis

- Urgent need to do maintenances for the existing gauge stations and water level sensors in the wadis like Zarqa Maien, Mujeb, King Talal Dam, and others.

- Flood management by building new dams, meanwhile our priority is wadi Al Nukheila dam, but also JVA prepared list of proposed sites in order to control floods as a new source of water.

- Field inspection, with the help of Japanese experts, on various valleys and evaluation of the possibility of installing EWS

**KEYWORDS:** Jordan; Flash Floods; Water Management; Dam; Wadi; Arid; MENA Region

# *FLASH FLOODS: CHALLENGES AND MITIGATION IN ALGERIA*

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**ABSTRACT**

Algeria has experienced devastating floods in the past that caused considerable damages. They caused the loss of human lives and several damages including building, destruction of roads and rail lines…etc. These events are regular and intensified by other factors than weather situations. In fact, many of them occurred when there is no exceptional rainfall event. The flood of Bab El Oued district (Algiers) is probably the major and worst disaster which affected the country. In 10 November 2001, this event caused 800 fatalities, 150 missing persons, 30,000 people left homeless and an economic damage estimated to over 250 million euro. The second important flood occurred on 2 October 2008 in the oasis town of Ghardaia (South of the country). This event has been caused by heavy rains and left 33 human losses, 50 injuries and approximately 2,000 homeless. Many others flood events were registered in many parts of Algerians cities. These flood events are often characterized as rapidly developing events which leave little time for people to take actions in order to reduce the risk life and mitigate the infrastructure damages. This phenomenon called "flash floods" is not well known in Algeria.

In this paper, we focus on the flash floods problem in Algeria and the challenges of its mitigation: what we know and what we can do. We present the synthesis of several scientific works and several research projects on this phenomenon. We discuss the different aspects of flood analysis, and their evolution in relation to urbanization and climate change. As well as the various observations concerning the evolution of the floods in Algeria.

**KEYWORDS:** Flash Flood; Flood Risk Management; Flood Warning; Flood Forecasting; Urban Flooding; Algeria

# *EVALUATION OF THE FLOOD RISK AT THE MEDJERDA RIVER USING THE HECRAS 2D MODEL*

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**ABSTRACT**

Due to the recurrent occurrence of major floods around the world, especially in Tunisia, several tools and methods were developed to alert and reduce the human and socioeconomic losses caused by flooding. In Tunisia, especially in the Medjerda watershed, North West of Tunisia, the recurring of floods is becoming more frequent. The Medjerda Wadi was touched by destroyed flood in 1973, 2004 and 2015. The purpose is to implement the different methods of hydraulic modelling, mainly regarding the floodplain modelling in order to elaborate a flood risk map. Thus, we are interested in hydraulic modelling applied to the Medjerda Wadi because flood forecasting deserves special attention, nowadays several methods have been developed for flood forecasting, especially numerical modelling. Due to the heavy construction and simulation, 2D model is used. The delineation of flooded areas as well as the definition of water levels and velocities in the flood plain were evaluated. In this context, hydraulic modelling can certainly provide reliable and accurate results especially when these models can exploit the extensive information provided nowadays to help stakeholders to deal with this major natural disaster. The HECRAS 2d model was used to evaluate the flood risk at the Medjerda Wadi (Ghradimaou Bousalam river as well as Rarai and Mliz tributaries). Two events were modelled, 2003 and 2015 years. Results of the flood plain corresponds to the 2003 year event were calibrated to compare the water depth simulated and the water depth recorded by the CRDA of Jendouba and the DG/BGTH authorities. The simulation results of the 2015 year event were validated using a satellite image SENTINEL1. After calibration and validation of HECRAS model, we convert the flood plain in Shape file. Finally, we collected and constructed a spatial data to establish a risk map.

**KEYWORDS:** Flood Risk; Medjerda River; HECRAS Model

# *ON WATERSHED DELINEATION FOR FLOOD MODELLING IN LOWLANDS*

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**ABSTRACT**

Flood modelling has become an important tool for flood management and flood risk evaluation. A flood model crucially is related to the determination of the model region, usually the watershed or catchment. The task of delineating a watershed consists of identification of its boundaries. By definition these are no-flow boundaries, as water divides separate one watershed from the neighbouring ones. Concerning flood modelling in the lowlands this procedure includes several difficulties. (1) As topographic gradients are very low, inaccuracies and measurement errors in digital elevation maps lead to severe uncertainties concerning the location of the boundaries. We demonstrate this for a study region in Al Batinah, Oman. (2) The stream and flood plain may change as effect of strong flooding events, due to sediment transport, which may open new pathways or block previous ones. Debris flow may aggravate this situation. The change of the stream channel may affect the watershed significantly. (3) In coastal lowlands the seaside boundary may be altered due to climate change. (4) Water divides, identified under normal conditions, in case of a flood event may become partially inundated and may thus not separate flow regimes anymore. In our contribution the problem is illustrated on a hypothetical case study. Moreover a strategy is outlined, how the latter problem can be overcome. The outlined delineation concept has to be modified, which requires the anticipation of a maximum inundation depth. With increasing depth the watershed to be used in a flood model may become much larger. We conclude that in lowland flood modelling the dependency on the various conditions has to be taken into account. Due to the changing conditions it is generally not possible to extrapolate from one flood event to another. Instead of static flood risk maps flexible fast simulation software has to be favoured in order to take the mentioned dependencies into account.

**KEYWORDS:** Flood Modelling; Watershed Delineation; Lowlands

# *RAINFALL - RUNOFF MODELING WITH A DEEP LEARNING NEURAL NETWORK MODEL*

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**ABSTRACT**

Rainfall runoff modeling is the pillar of hydrological applications. Effective flood protection is based on the performance of models to predict runoff with high accuracy. In order to develop a robust model, calibration with informative observed data is needed to simulate watersheds behavior. However, longer calibration data length is, more suitable to have deeply analysis because it contains more information about the rainfall-runoff process. With the development of the deep learning techniques, new opportunities have been open for hydrological models. In this study, we evaluated the performance of the Long Short-Term Memory (LSTM) model to capture rainfall runoff relationship with different learning size. Twenty catchments which have been obtained from the freely available CAMEL data set have been used to test the model. This database was developed with meteorological satellite data sets (inputs) and measured runoff (outputs). The developed LSTM model have been carried out on different size of training data (3, 6, 9, 12 and 15 years) and the rest was used for model assessment by means of conventional metrics. This configuration has been applied with a Feedforward Neural Network (FNN) model as a benchmark in order to illustrate the performances of the LSTM model. Based on different efficiency criteria [Nash-Sutcliff Efficiency (NSE), Root Mean Square Error (RMSE) and Determination Coefficient (DC)]. The achieved results proved that the LSTM model outperforms the FNN model. By comparing the LSTM and FNN models across all catchments, the average NSE obtained were 0.70 and 0.61, respectively. Thus, the RMSE difference (average) between both models is around 10%. Moreover, using 10% of data with the LSTM model was sufficient to have superior performances compared with FNN model with 50% of data. It was also found that the LSTM model performances increase with the increasing of learning data size until 40% of the global observations. However, the FNN model reach its limit at 20% of data (slight difference with more data). Finally, we can conclude that the LSTM model is a powerful machine learning model which is able to model the rainfall-runoff relationship with a minimum data length. It can be a useful tool for regions with limited observed data.

**KEYWORDS:** CAMEL; Data Length; Hydrological Modelling; Long Short Term Memory (LSTM); Scarce Region

# *FLASH FLOOD MAPPING IN JORDAN*

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**ABSTRACT**

Despite the valuable progress that has been accomplished in the field of flood disaster management through engineering achievements, civil and environmental studies, floods continue to be a major challenge in many parts of the world, this is mainly due to fast population growth, urbanization expansion exacerbated by climate change.

As Jordan, a country with an upper middle income, has always been prone to flash floods due to its location and its topographical characteristics, floods cause serious damage to the infrastructure capital of Jordan which has a number of implications for agriculture and infrastructure in the whole country. During the last decades, Amman, the country's capital, has experienced serious flash floods that has damaged properties and assets and has also led to loss of human life. Therefore, it is necessary to understand and assess flood risk in the city to identify flood-prone locations and also to develop various means to cope with the problem through preventive and remedial measures.

Due to the fact that there are several factors influencing flash floods, the methodology of this study consists, firstly, of defining the factors influencing flood risk attributed to the case of Amman based on literature review, secondly, of collecting all the required data for these factors to do several related analyses. ArcGIS "Geographical Information System" tools were used to analyze the factors that influence flash flood risk in Amman. In the study, a Digital Elevation Model (DEM) was used for conducting spatial analysis in ArcGIS using its Arc-Hydro extension tools to delineate the catchments and the drainage system of the study area. DEM was also used to produce a slope map and to define flow accumulation in wadis (valleys) which is critical when mapping floods.

Three main maps for flood generation, flood accumulation and flood vulnerability were constructed in ArcGIS based on the factors influencing flood risk by applying the Weighted Linear Combination (WLC) method. Results indicate that around 77% of the study area acts as flood generation zones, 64% of the study area is within the risk zone, and around 24% of the population live in highly vulnerable locations to flood.

The maps produced were used as a foundation to propose locations for applying flood control measures. Flood risk coupled with rapid urbanization is increasing and as such, structural flood management practices alone are not sufficient to reduce the risk. This study proposes to update and develop the current early warning system to enable an earlier and more effective response to floods which could reduce flood impacts and also enable prediction of future extreme weather events. Also, several applications of green infrastructure technologies are proposed as structural solutions to mitigate flood magnitude. This study provides the Greater Amman Municipality and other concerned national institutions with a solid basis to understand the flood risk situation in Amman and a set of recommendations to enhance their future development plans especially for reducing disaster risk in Amman.

**KEYWORDS:** Flood management; Flood risk; Green Infrastructure; Early warning system (EWS); GIS; Amman; Jordan

# *FLASH FLOODS ROAD MAPPING: THE EGYPTIAN EXPERIENCE*

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**ABSTRACT**

Flash floods are phenomena that may happen anywhere in Egypt at any unexpected time and therefore the management of such phenomena is extremely difficult. The unexpected nature of flash floods keeps the decision maker under the pressure of trying to have full preparation to face the unknown attack at any front at any time.

Flash floods in Egypt may hit the oil cities on the Red Sea, South, Middle, and/or North Sinai Peninsula, the Southern cities of Upper Egypt, the Northern part of the Nile Delta, the Suez Canal cities (Port Said, Ismailia, and Suez), the North West coast and the Southern cities on the Red Sea (Halaib and Shelateen).

If the country is to implement protection measures against flash flood all over the country, the cost will definitely be unbearable and completely unaffordable. This paper is an attempt to help the Egyptian decision makers establish a sort of priority list of which part of the country urgently needs protection and which part can be postponed for some time. The idea is to give weight to each of the governing factors such as history of flash floods in the region, climatic conditions, elevation, land slope, proximity to a sink, soil type, availability of building material, manpower, cost of protection and availability of funds, cost recovery, community contribution, private sector and civil society participation, value of exposed assets, … etc.

The results of this analysis is expected to lead to a road map telling decision makers what is beyond planning, strategy and vision of solutions to overcome the problems connected to flash flood and how to convert these problems into benefits and gains

**KEYWORDS:** Road Mapping; Prioritization; Gains and Losses; Management and Control.

# *CAUSES AND CONSEQUENCES OF FLASH FLOOD IN (SAQR PARK AREA, UNITED ARAB EMIRATES (UAE)*

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**ABSTRACT**

Flash floods are common phenomena in the arid climatic conditions of the UAE when they are associated with torrential rainfall events. A case study area, namely Saqr Park, located in Northeastern UAE was selected for investigating the cause and consequences of flash flood that happened during April 2019. This event resulted in flooding of the park area and surroundings of about 4 km2 giving rise to severe destruction of the park's infrastructure including buildings, roads, vegetation and landscape. The flooding has also caused damage and failure of most groundwater wells in the park area. A combination of different investigation methods was applied to evaluate the reasons that led to flooding, environmental consequences and future remediation actions. Three ERT profiles were carried out to investigate the subsurface geological conditions of the invaded area. The results of ERT survey indicate different values of resistivity ranging from a few Ohm.m to > 4500 Ohm.m, which reveal wide variation in the aquifer lithology (clastics to carbonates) and groundwater salinity. Groundwater level in the area was at about 18 m from the ground surface and the delineated catchment area was about 72 km2. This catchment area represents the main source of water supply where precipitation rates in the surrounding meteorological stations during the flooding event period reached up to 92 mm .The data of electrical resistivity tomography (ERT), groundwater monitoring and drainage pattern analysis revealed complex factors that have led to flooding event. In addition, lack of any protection structures around the park area such as dams, levees, floodwalls, diversion channels may have contributed further to this environmental hazard. At the same time there were no small dams or early warning system along the major valley that could help preparing actions to meet the flood event intensity before it occurred. To avoid future risk of flash flooding hazards in the study area, more data on the hydrogeological conditions in the fluvial fan and the major valley nearby the park area are required. In addition, plans for constructing of water retaining structures in the valley drainage course can help regulating and mitigating the impact of future intensive rainfall events.

**KEYWORDS:** Flash flood; hydrogeology; ERT; UAE

# *ASSESSING THE IMPACTS OF TROPICAL CYCLONE HAZARDS AT LOCALSCALES BY DYNAMICAL DOWNSCALING EXPERIMENTS*

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**ABSTRACT**

Depending on the geographical features, there are various types of extreme weather that would spawn disasters. A tropical cyclone is one of the major extreme phenomena, and develops in the Pacific Ocean, the Atlantic Ocean, and the Indian Ocean and affects their coastal regions. In addition, assessing the impacts of climate change on such extreme phenomena is important to prevent and mitigate anticipated disasters in a future warmed climate. Furthermore, hazard information at local-scales is required because the resulting phenomena occur depending on their local geographic and topographic features.

Since the Innovative Program of Climate Change Projection for the 21st Century (KAKUSHIN Program, FY2007-2012) funded by the Japanese Government, we have been studying the impacts of extreme weather in future warmed climate conditions under the subsequent Program for Risk Information on Climate Change (SOUSEI Program, FY2012-2017) and the latest Integrated Research Program for Advancing Climate Models (TOUGOU Program FY2017-). Heavy rainfalls and strong winds induced by tropical cyclones were quantitatively examined as case studies for specific disaster-spawning events.

In this paper, we describe some of the case studies on typhoons that made landfall over the Japanese islands by employing a dynamical downscaling approach with a regional-scale meteorological model. The impacts of future global warming were investigated through a pseudo-global warming (PGW) experiment. In addition to the dynamical downscaling with a meteorological model, further downscaling at building scales in urban districts was conducted to investigate local-scale hazards in urban areas. Some recent developments on the urban-scale hazard assessment using a large-eddy simulation (LES) model will be presented. Explicit representations of urban buildings enable us to quantify wind fluctuations within urban districts.

From our studies, we have found that by employing a dynamical downscaling approach and the PGW experiments we are able to quantitatively assess the impacts of typhoons on local-scale meteorological hazards. Building-resolving LESs prove to be promising to provide quantitative hazards within urban districts.

**KEYWORDS:** extreme weather; tropical cyclone; dynamical downscaling experiment; climate change; large-eddy simulation

# *IMPLEMENTATION OF HYDROLOGICAL AND HYDRAULIC MODELS TO FORECAST RIVER FLOOD RISKS AND PROPOSITION OF MANAGEMENT MEASURES. CASE STUDY OF NYABUGOGO RIVER BASIN IN RWANDA*

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**ABSTRACT**

Nyabugogo River is being flooded every year resulting in human and economic losses. For sustainable flood management; flood risk forecasting is a useful component to show the extent of floodplain for each event. Therefore, this study aims to forecast Nyabugogo river flood risk and propose mitigation measures to reduce flood impacts by using HEC-HMS combined with HEC-GEOHMS and HEC-RAS integrated with HEC-GEORAS. Nyabugogo river floods are mainly due to high topography, rainfall, soil texture mainly composed of clay and informal settlement; urbanization. The peak runoff of 515.7; 680.2; 761.5 and 875.5 m3/sec were founded for 10, 30,50 and 100 return period year respectively and flood inundation area increased slightly from the lower event to the high event with 423.35; 426.11; 428.08 and 430.60 ha for 10,30,50 and 100 return period year respectively. Also the water depth increased slightly with the return period where the high water depth of 3.24 m was obtained for 100 year return period. For all the event modelled, the more vulnerable land use included annual cropland, open grassland, open shurbland, settlement, sparse forest and wetland; with 54.804, 53.672, 53.238, 54.804, 139.359, 50.106 ha of inundation area for 100 year return period for each land use respectively. Consequently, some proposed mitigation measures include construction of storage reservoir at the upstream location of the reach; relocation of infrastructures within the flood plain area; buffer zoning around Nyabugogo River, Rain water tank for each house and raising public awareness on flood risks. Thus, this study can provide a basic support for decision making and also can help in the planning and management of land use and future probable flood event within the catchment.

**KEYWORDS:** Modelling; HEC-RAS; HEC-HMS; Nyabugogo River Basin

# *LONG-TERM TREND ANALYSIS AND VARIABILITY OF ANNUAL AND SEASONAL PRECIPITATION OVER THE MENA REGION*

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**ABSTRACT**

In the Middle East and North Africa (MENA) region, flash floods become more frequent and devastating within the last 20 years based on the observational records. Understanding the reason why the extreme flash floods are increasing in frequencies and magnitudes are still hampered by the lack of observational and historical data. Therefore, the study aims to perform long-term spatiotemporal analysis to come up with understanding the trend of extreme events and spatiotemporal variability. The CRU TS4.0 datasets (CRU TS = Climatic Research Unit Timeseries), monthly timeseries of precipitation (1901- 2015) is used to assess the spatial and temporal trend variability. In addition to use the data of PERSIANN-CDR (1983-2018), to analysis the present conditions of extreme events and Global Climate Model (GCM) data (2020-2100) is used for the future extreme events analysis. The available rain gauges data over Oman were firstly used to validate the feasibility to use such datasets. The modified nonparametric Mann–Kendall and Sen's methods were applied to assess variability trend over the MENA region. The results show that there is very high spatial variability from one country to the others. The same analysis and statistic indices were used for the future climate data. The results suggest that the extreme climate events will generally increase in some regions and decrease in others with no statistical significance trend. Further investigation is recommended for understanding variability and trends of extreme events based on finer temporal and spatial resolution.

**KEYWORDS:** Extreme Flash Floods Events; Trend Analysis; Spatial And Temporal Variability; MENA Region: Climate Change.

# *BEACH EROSION AND WADI SEDIMENT SUPPLY ALONG AL BATINAH COAST, OMAN*

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**ABSTRACT**

Human interventions in coastal area and river basin often result in serious shoreline recession of sandy coasts and delta shorelines. Sediment deposit in a dam reservoir is one of typical examples that causes beach erosion due to reduction of sediment supply from the river basin. In addition, it is predicted that future sea level rise causes further serious beach erosion all over the world. In this study, shoreline change on Al Batinah Coast, Oman has been investigated by combining field observation and satellite image analysis. In addition, discussions have been made for the relationship between sediment supply from wadis and shoreline change in the study area.

**KEYWORDS:** Beach Erosion; Al Batinah Coast; Oman; Wadi Sediment; Satellite Image Analysis

# *ESTIMATION OF SEDIMENT YIELD IN ARID WADIS USING REMOTE SENSING AND GIS*

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**ABSTRACT**

Estimation of erosion is essential to issues of land and water management, including sediment transport and storage in lowlands, and reservoirs. Rates of soil erosion can be estimated using erosion prediction equations developed during the last four decades. Among these algorithms are Universal Soil Loss Equation (USLE) and its recent updated the Revised Universal Soil Loss Equation (RUSLE) or Modified

University Soil Equation (MUSLE). In this study remote sensed data were used as an open source/available data to estimate the soil loss using the GIS techniques and raster algebra used to facilitate the numerical computation when applying the

Universal Soil Loss Equation (USLE). South Sinai region, Egypt, which suffers from flash floods cause soil loss in the main wadis, has been selected to check the proposed algorithm results and calibrate the model. Field survey measurements were done for sediment loss volumes accumulated upstream two dams located on a major wadi “wadi water” after a certain rainfall event. The results estimated for soil loss volumes accumulated upstream the two dams ranged between 0.73 to 0.85 the measured values. The proposed algorithm provides a reliable technique to build a vital database to estimate soil erosion in main wadis.

**KEYWORDS:** Soil Erosion; USLE; Remote Sensing; GPCC; Sinai, Wadi Wateer; GIS

# *RESERVOIR SEDIMENT MANAGEMENT PRACTICE IN SUDAN: CASE STUDY OF KEG DAM*

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**ABSTRACT**

Sediment problem one of the concurrent hot issues affecting operations of reservoirs and irrigation networks in Sudan. Most of the Rivers cross Sudanese borders are coming from Eastern Africa Plateau, which acts as a sediment sources for River Nile and its tributaries. Khashm El Girba Dam (KEGD), across Atbara River in Eastern Sudan, is a multi-purpose dam, which was constructed in 1964. The Atbara River is a branch of the River Nile system, the River carrying a huge amount of sediment during the flood period. After 7 years from construction, in 1970, the dam faced a critical problem, which could have led to a disaster when it was discovered that the storage is not enough to satisfy the downstream requirements due to sediment deposition. This study discusses the sediment management practice which used in KEGD and its impact on maintaining the reservoir capacity. Operation Policy (OP), Trap Efficiency (TE), sluicing and Flushing Operation (FO) were discussed. The adopted management practice was succeeded in removal of considerable amount of silt and maintaining the lifetime of the reservoir.

**KEYWORDS:** Sluicing; flushing operation; bathymetric survey; KEGD

# *INTERPLAY BETWEEN SEASONAL SURFACE RUNOFF AND GROUNDWATER IN AL JAWW PLAIN UAE*

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**ABSTRACT**

Surface runoff is crucial for local recharge of the groundwater aquifer in arid regions where rainfall events are strongly linked to short season. We present here a case study from Al Jaww plain that represents a large aquifer in the eastern arid dominated climate in the UAE. The plain lies between two significant catchment areas namely Oman and Hafeet mountains that provide most of the groundwater recharge sources. However, the torrential rainfall during winter season from January to March directly contribute to surface runoff on the plain which may sometimes associated with flooding events. Groundwater quality of the study area is one the best in the UAE with salinity of < 1000 mg/L. The lithology of Al Jaww plain is characterized by different thicknesses of Quaternary clastics (gravel, sand and mud) with maximum thickness of about 100 m. The interplay between surface runoff and groundwater during torrential rainfall events is partly controlled by the infiltration rate of the aquifer system. Accordingly, several infiltration tests combined with subsurface data from drilled wells climatic conditions were used to investigate differential transmissivity of aquifer and the effect on flooding possibility. The results reveal that the clastic sediments have wide range of hydraulic conductivity (1 to 225 cm/s) depending on the test site location. High values of the infiltration rates are acquired in the eastern side of the study area compared to the western side. This difference in hydraulic conductivity of the surface sedimentary cover seems to have significant effect on the degree of surface water infiltration and flood direction. Groundwater flow direction and level may furthermore enhance the flood conditions depending on the connectivity between the surface and subsurface hydraulic conductivity. Although, the study shed light on the main criteria that contribute to flooding in this region, more data on drainage pattern system analysis and infiltration tests are needed to better elucidate the relationship between surface hydrology and groundwater conditions.

**KEYWORDS:** Runoff; Groundwater; Infiltration; UAE

# *A NOMINAL MODEL UPPER BOUNDING FLASH FLOOD EVENTS IN A WADI OF THE JORDAN RIFT VALLEY*

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**ABSTRACT**

The Jordan Rift Valley refers to the depression below the sea level extending over the range of latitudes 30-33 N and longitudes 35-36 E, including Lake Tiberias to the north and the Dead Sea in the middle, surrounded by Jordanian Highlands and Judaean Mountains. A study site has been established in the Lisan Peninsula of the Dead Sea. An innovative bottom intake structure was constructed at the downstream end of a wadi having a 1.12 km2 barren catchment area, in order to harvest the runoff water of flash floods into a reservoir. An observation system is operating since September 30th, 2014, so that time series data of rainfall and runoff in flash flood events are minutely acquired. Due to the extreme arid environment, water current as the runoff from the catchment is ephemeral, and the flash flood events can be clearly distinguishable from each other. Thirteen flash flood events with total runoff volume more than 100 m3 have been successfully recorded during five winter rainy seasons, though the observation system failed to record other two significant events due to technical problems. An autoregressive model with exogenous input (ARX model) is identified to tightly bound each runoff time series from above using the simplex method of linear programming. The exogenous input part is compatible with the conventional unit hydrograph method, while the autoregressive part is regarded as a discretized differential operator of fractional orders. Then, the transfer function from rainfall intensity to runoff discharge is systematically determined for the linear fractional differential equation approximating each linear ARX model. As usual in the system-theoretic framework, the transfer functions are evaluated in terms of gains. Finally, an example of nominal model is presented to envelope the all transfer functions for the thirteen flash flood events. Such a nominal model shall be applied to practical problems of risk assessment or water resources management in future studies.

**KEYWORDS:** Rainfall-Runoff Model; Water Harvesting; ARX Model; Linear Programming; Fractional Calculus

# *ANALYTIC HIERARCHICAL PROCESS IN SELECTING ARTIFICIAL NEUTRAL NETWORKS FOR SUSPENDED SEDIMENT LOAD MODELLING*

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**ABSTRACT**

Precision in suspended sediment load (SSL) estimation and prediction in a river system is an important task for sedimentologists, hydrologists, hydraulic and geomorphologists for different reasons, including the river channel morphology that impacts the water resources reservoirs capacities. Artificial neural network (ANN) has been applied successfully to predict suspended sediment load. Four feed-forward neural network models were developed, based on pre-processed daily time series through clustering, Year-based clustering (Y-ANN), Month-based clustering (M-ANN), season-based clustering (S-ANN), and y-partitioning-based clustering (YP-ANN). Most of studies apply different set of statistical metrics to evaluate the model performances. The present paper illustrates the capability of analytical hierarchical process (AHP) to rank and select the artificial neural network (ANN) in modelling the relationship between suspended sediment load and flow stream discharge in Eel river station, Scotia, California, USA, with respect to the importance of six statistical metrics criteria, coefficient of determination (R2), Nash-Sutcliffe efficiency (NSE), Percent-bias (PBIAS), ratio of the root mean square error to the standard deviation of measured data (RSR), error in peak sediment (EPS), and error sediment yield (ESY). Results showed that overall preferences for M-ANN model, YP-ANN, S-ANN, and Y-ANN Models were 28%, 27%, 23%, and 22% respectively. Sensitivity analysis was applied to find out the most critical criterion and performance measure.

**KEYWORDS:** Suspended Sediment Load; ANN; Clustering, AHP; Statistical Metric.

# *APPLICATION OF IMAGE IDENTIFICATION BY ARTIFICIAL INTELLIGENCE TO AERIAL PICTURES TAKEN FROM UAV FOR CHANNEL MANAGEMENT*

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**ABSTRACT**

On erodible bed channel, particle size of bed material in Wadi system reflects a tractive force of the flow. It might be important information, for example, for the construction of timber support on lateral wall of channel. In the case of fixed bed (exposing bare rock), the roughness of bed surface decides the velocity of the flash flow. For those reasons, it is expected that the distribution of the bed condition of Wadi system is observed. The conventional riverbed material survey uses sieves and weight scale or length scale, but it requires hard labour that regulates the number of data collection. In this study, we tried automatic classification of riverbed condition by using Unmanned Aerial Vehicle (UAV) and image recognition with Artificial Intelligence (AI) in order to improve the survey efficiency. This study was conducted at the study site in Japan as trial. Our study site is Mimikawa River that has a stream through a year, but the river bed material is exposed on the riverside and its particle distribution varies widely. Aerial photography with UAV was conducted widely in the study site in parallel with the grid-by-number method, conventional riverbed material survey, at several points. Part of the images whose particle size was evaluated by the conventional method were used for learning data. Rest of those were used for validation of the recognition. We used GoogleNet for automatic image classification by deep learning. In addition, particle size analysis using BASEGRAIN, an application for riverbed material evaluation by measuring the size of each stone in an image was tried. The survey efficiency for an image was compared between two methods of image analysis.

The median particle size could be classified with high accuracy by deep learning. Compared with BASEGRAIN, it was confirmed that the proposed analysis can perform down to a finer particle size. In addition, the survey efficiency has been greatly improved.

The potential of the evaluation of riverbed materials by using UAV and automatic classification with AI was confirmed. In further study, batch preprocessing system that enables the proposed method to be applied to the images taken under different conditions. Furthermore, learning various data with different shapes and colours of riverbed materials and improving the quality of the network are required.

**KEYWORDS:** UAV; AI; Automatic Classification; Particle Size

# *ANALYSIS AND CONSEQUENCES OF THE FLASH FLOODS IN NABEUL AREA*

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**ABSTRACT**

Flash floods in arid regions constitute a real threat not only for human life but also for the infrastructure such as roads and dams, the lands and the crops. During the last century, Tunisia was devasted by more than ten very strong flash floods, one each 10 years, all the regions of Tunisia have been affected. The most important events that still impact people's memories are those occurred in the whole country in 1969, in Medium and Lower Mejerda River basin in 1973, Sfax in 1982, center of Tunisia in 1990, Tataouine in 1995, Grand Tunis in 2003, Sabbalet Ben Ammar in 2007, and Redeyef in 2009. The most recently flash floods event is the one that devasted the Nabeul region in 2018; huge damages and few cases of human losses were unregistered. In Nabeul, the total rainfall was of about 200 mm during 5 hours that exceeds by 4 to 5 times the mean monthly value in this area. The rainfall intensity was 40 mm/h in Nabeul and 60 mm/h in Beni Khalled. Can we say these intensities were high or lower; generally speaking, the answer depends on the local circumstances such the catchment characteristics (shape, slope and land cover) as well as the topography and the infrastructure status. In general, an intensity of 2 mm/day is considered lower and an intensity higher than 30 mm/hour is relatively high. High intensity, as the value enregistred at Nabeul, combined with steep slopes of the catchment in this area, leaded to flash floods. Because Nabeul is a flat area and with very insufficient drainage capacities, these floods generate serious urban ponding; in some part of this city, the water level exceeded 1 m. This work will be focused on the diagnosis of the consequences of the flash floods in Nabeul area and on the hydrological analysis of the related events (rainfall and runoff). The huge consequences were not only due to water flow but also to sediments transport; indeed, small dams as well as soil and water conservation protections were destroyed and constituted the main source of the carried sediments. The statistical analysis of daily rainfall data for more than 50 years permit to estimate the return period of the rainfall event at Nabeul area to 200 years. The results of simulation using HEC RAS model showed that the capacity of urban drainage system and infrastructure is just enough to ensure the transit of run off generated by a rainfall of 20 to 50 years as return period. The carried sediments and large debris are aggravating factors.

**KEYWORDS:** Arid lands; Extremis Rainfall; Ponding; Hydrological Simulation

# *FLOOD HAZARD MAPPING FOR ARID BASINS IN THE EASTERN DESERT, EGYPT*

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**ABSTRACT**

Flash floods modeling, risk assessment, mitigation and management in the arid region are hindered by the unique characteristics of the wadi system, lack of powerful hydrological models and data deficiency. Considering these challenges, Wadi Qena was employed to compare several methods of flash flood hazard assessment. The first method is a hydrological modelling based where the flash flood index parameters have been calculated using a distributed hydrological model (Hydro-BEAM). A series of flash flood events from 1994, 2010, 2013, and 2014, in addition to synthetic virtual storms with different durations and intensities, were selected for the application of this study. The second method is the well-known El-Shamy method which applied frequently in the wadi systems. The third method for flash flood hazard assessment has been developed through this study deploying the geomorphometric indices that have high impact on the process of flash flood generation. That was based on an in-depth geomorphometric analysis for several parameters representing the topographic, scale, shape and drainage characteristics of the target basins and have been extracted using geographic information system (GIS) techniques. The results exhibit strong correlations between scale and topographic parameters and the hydrological indices of the wadi flash floods, while the shape and drainage network metrics have smaller impacts. Finally, the developed flood hazard susceptibility method was applied to the major wadi basins in the Eastern Desert of Egypt providing flood hazard map for the whole region.

**KEYWORDS**: Flash Flood Index; Geomorphomteric Analysis; Flood Susceptibility Assessment; Wadi Hydrology

# Abstract – Posters

# Session A

Poster Code: SA-1

# *CHANGE IN BED SOIL CHARACTERISTICS AND FLOOD POTENTIAL IN RESPONSE TO SEDIMENT TRANSPORT AND FLOOD MITIGATION STRUCTURES*

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## ABSTRACT

In wadi system, the impact of flood mitigation structures on channel pedology, lithology and flood potential are still not fully understood. Thus, a critical linkage between changing soil characteristics and flood potential is needed to be identified. Previous studies show that such structures contribute in reducing the flow velocity. Consequently, deposition takes place causing soil clogging. The soil clogging in wadi systems results from physical clogging. Physical clogging phenomena (PCP); occurs when fine suspended particles in the floodwater deposits inside the topmost porous surface layer of the basins/streams bed. This research focuses on understanding the impacts of the three types of PC (surface, Inner, or mixed) on infiltration rates. Through this research, each type of clogging and its effect on the infiltration rates for different soil and suspended particle sizes combinations are examined. Such examination targets: 1) effect of different particle sizes combinations on infiltration rates, 2) identifying the sensitivity of the depth and the developed soil characteristics of the clogged layer, and 3) the influence of different hydraulic pressure application and its significance on the clogged layer. This research adapts numerical simulation to study nine synthetic scenarios of clogged layers with various soil sizes combinations using Hydrus Numerical Simulation Model. This research concludes that: (1) soil infiltration rates reduced by one to two order of magnitude, (2) the relation between size of suspended particle and size of the bed soil control the amount of reduction in infiltration rates, (3) inner clogging causes the maximum reduction in infiltration rate, and (4) This new clogged layer significantly reduce the infiltration rates causing indirectly increase in the flood quantities for same events. Furthermore, this research suggests that flood mitigation structures should include recovery plan for sustaining flood potential. Additionally, post-construction monitoring and sediment transport management is very important for maintaining lifetime of such structures.

**KEYWORDS:** Hydrogeology; Clogging; Wadi System; Flash Flood

Poster Code: SA-2

# *STATISTICAL EVALUATION OF HIGH-RESOLUTION PRECIPITATION PRODUCTS IN A HYDROLOGICAL MODELING OF EASTERN NILE BASIN*

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**ABSTRACT**

Satellite precipitation products become a vital tool for hydrologists, especially in scarce data regions. Where they have become an alternative sources of sparse rainfall gauges data for various hydrologic applications. However, their accuracy and performances must be evaluated by geographical position, topography, and climate due to their variation from region to region. On the other hand, Blue Nile is considered the most important tributaries of Nile River which it provides the part of the river flow. Therefore, the main aim of study was evaluating of two High-Resolution Precipitation products over the Blue Nile basin by using categorical metrics (Probability of Detection (POD), False Alarm Ratio (FAR), equitable threat score (ETS) and Frequency Bias) and statistical indicators (Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Relative Bias (RE), and Correlation Coefficient (CC)) to assess its ability of detection of rainfall amount and event correctly. Moreover, Hydro-BEAM (Hydrological River basin Environmental Assessment Model) fully distributed model used to assess their capability to predict streamflow. Hydrological monthly simulation was estimated at various stations in the Eastern Nile basin. Furthermore, an attempt is made to adopt Hydro-BEAM to consider into the runoff simulation the effect of dams along the Eastern Nile River. This trial will provide to estimate the availability of water resources more realistic under future challenges imposed by climate change or proposed and existing Ethiopian plans for new dams construction.

**KEYWORDS:** High-Resolution; Satellite; Precipitation; Hydro-BEAM; Blue Nile; Eastern Nile

Poster Code: SA-3

# *STUDY ON THE IMPACT OF CLIMATE CHANGE IN THE MADJERDA WATERSHED, ALGERIA*

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**ABSTRACT**

The Madjeda River originates in the Atlas Mountains of eastern Algeria, crossing Tunisia's northern region to the Mediterranean at Tunis Bay. In January 2003, flood submerged the downstream alluvial plains near the capital city of Tunis, causing widespread damage to crops and homes that affected the region socially and economically.

The recurring of floods is becoming more remarkable in the Medjerda watershed (one of the most important basin in the Maghreb region). In order to limit the risks, several studies were performed to examine the Medjerda hydrodynamic. The observation indicated a strong correlation between flash floods and the sediment transport phenomena.

The objective is divided in two steps. First step is to model the Madjedra Basin reaction during extreme rain events (flash flood), which will include rainfall-runoff modelling based on climate change impact. The second step is to examine the sediment dynamics by understanding flash floods spatio-temporal variability as well as reservoir sedimentation from the flash flood sediment yield.

This study targets the prediction and reduction of flash floods disaster risk, as well as the improvement of the integrated water management plan.

**KEYWORDS:** Madjerda Watershed; climate change; flash flood; sediment transport; water resources management.

Poster Code: SA-4

# *FLASH FLOOD MODELING, AND MITIGATION AT THE HISTORICAL SITE OF PETRA, JORDAN*

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**ABSTRACT**

Petra is one of the most important historical sites, not only in Jordan but in the whole world. It was even chosen as one of the New Seven Wonders. Petra is located in the Southwest of Jordan. It used to be the capital of the Nabatean kingdom. Flash floods bring about a major threat to the tourists and the locals in the city. Unfortunately, the flash floods modeling in the MENA region is obstructed by the data availability and the lack of the appropriate hydrological models. A flood analysis model was developed and calibrated for Petra basin using the Rainfall-Runoff-Inundation (RRI) model. The calibration and the validation procedures were done based on observed data in the region. Moreover, the model was applied on different recent flash flood events using Satellite data such as PERSIANN, GSMaP, GPM and GPCC. Furthermore, a synthetic rainfall analysis was applied on the calibrated model to estimate the scenarios of different extreme events and to understand the physical behavior of the catchment. Moreover, the model is going to be used to estimate the behavior of different events with different return periods. Subsequently, some mitigation measures are proposed and analyzed using the calibrated model.

**KEYWORDS:** Flash Flood; Hydrological Model; Rainfall-Runoff-Inundation (RRI; arid; extreme events; mitigation; satellite data

Poster Code: SA-5

# *MAPPING FLOOD CONTROL PROJECTS: AN (HISTORICAL) OVERVIEW OF FLOOD PROTECTION STRATEGIES IN THE PHILIPPINES*

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**ABSTRACT**

Flooding in the Philippines has been a problem since the pre-Hispanic time because most settlements are in very close proximity to the ocean, rivers and other bodies of water. However, it can be noted that in the past, the placement of towns and villages and even the design of houses and buildings took into consideration flooding and other natural phenomena in their location and design. The effect of these calamities was aggravated by the uncontrolled urbanization which brought about even bigger problems. In order to mitigate the effects of flooding specially in highly urbanized areas, several flood control projects have been undertaken by the government. But despite of these efforts, the problem persists and continues to threaten the growing population especially with the threat of climate change. Therefore, it is very important to take a look at the flood control projects and their effectiveness in solving the effects of flooding. In order to be able to do this, all the significant projects of the government form the pre-Hispanic up to the present time has been recorded and evaluated in terms of effectiveness as experienced in the immediate flooding events after the completion of the project. It was found that the most effective solution in mitigating the effects of flooding is mostly non-structural in nature, however, for extreme events, structural solutions are inevitable.

**KEYWORDS:** Flood Control, Disaster Adaptation, Disaster Preparedness, Disaster Prevention

Poster Code: SA-6

# *ANALYSIS OF VARIABILITY AND TRENDS OF EXTREME RAINFALL EVENTS OVER ARAB REGION FOR THE PERIOD 1983-2019*

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**ABSTRACT**

Climate change is a serious issue resulting in global variation in the precipitation pattern. The effects of poorly estimated spatio-temporal rainfall fields are visible in particular for arid and semi-arid regions, where rainstorms show a great variability in space and time. One of the major problems in examining the climate record for changes in extremes is a lack of high-quality, long-term data. Therefore, in the current study, spatial and temporal rainfall variability and trend has been analysed over a period of 36 years (1983-2019) using PERSIANN-CDR data for Arab Region. Bias correction factor of PERSIANN data was estimated using the available daily rain gauge's data in Oman. Long-term annual average rainfall, coefficient of variation of annual rainfall and precipitation concentration were computed to show the temporal and spatial variability of rainfall. For examining the trend direction and magnitude of change over time, the statistical trend analysis techniques namely Mann-Kendall test and Sen's slope estimator test were used. The same analysis and statistic indices were used for the future climate data using Global Climate Model (GCM) data (2020-2100). The results showed an increase in extreme events frequency and intensity with high variation in time and space over the region, which gives an indication of the precipitation response to global warming. Therefore, there will be a need for further investigation for understanding variability and trends of extreme events for each country separately. Small regional scale analysis would be of great importance for such area where structural mitigation measures are not well-designed to withstand and resist climate change impacts.

**KEYWORDS:** *Climate change; Extreme events; PERSIANN-CDR data; Mann-Kendall; Sen's Slope; Arab Region*

Poster Code: SA-7

# *FLASH FLOOD PREVENTION AND MITIGATION OPTIONS FOR HERITAGE CITY OF SANA'A DUE TO THE IMPACT OF CLIMATE CHANGES.*

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**ABSTRACT**

Yemen, in general, is vulnerable to flash floods, floods (coastal storm surge and tsunami), earthquakes, landslides and rockslides, and volcanic eruptions. Heavy rain from Tropical Cyclones has caused severe flooding in Socotra Island and coastal districts of Al Maharah and Hadhramout Governorates in Yemen and parts of neighbouring Oman. Over 8,600 houses and another 4,000 huts in both Governorates were totally or substantially damaged, leading to as many as 40,000 internally displaced persons (IDP). Flash floods caused major infrastructure damages, including disruption to roads, airports, electricity supply systems, water supplies and sewage disposal systems.

The Old City of Sanaʿa, is a UNESCO World Heritage Site is vulnerable to the impacts of climate change which means that adaptation is necessary and mitigation is possible in the context of sustainable development. Floods, especially flash floods, have killed many people in Sana'a in the last 3 years. At present there is no comprehensive survey on the role which planning can play in adaptation and mitigation. The impacts of climate change will depend on the baseline condition of the water supply system, energy supply and the ability of water resource managers to respond not only to climate change but also to population growth and changes in demands, technology, and economic, social and legislative conditions.

The research objective is to develop an appropriate flood mitigation measures which enables rural people in the heritage city of Sana'a to reduce flash flood risk due to the climate changes. The research Methodology was carried using Integrated Flood Management (IFM) concepts a methodology which helps identify solutions (either policy options or investment projects) for an efficient allocation of scarce financial resources.

The findings of this research will fill a major gap in knowledge by application of Integrated Flood Management (IFM) that be complemented by specific analytical elements in order to properly consider impacts of climatic changes in the heritage city of Sana'a and related risks; uncertainty of climate scenarios; climate change adaptation policies; and long-term adaptation interventions and investments.

**KEYWORDS:** Flash Flood Prevention; climate change; Mitigation Options

Poster Code: SA-8

# *IMPLEMENTATION OF THE TRAPEZOID-SHAPED CSG DAM AT WADI ABADI, EGYPT*

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**ABSTRACT**

Toshka Company is a leader in protecting cities and roads from floods and sand dunes since 1997.

Projects implemented in this field:
1- Construction of 3 protection dams & an artificial lake in qadira valley - water valley - south Sinai
2- Construction dam at wadi al akhdar – Abu Rudies - south Sinai
3- Construction dam at wadi Soual - St. Catherin -south Sinai
4- Building a supportive wall of rubble to protect Lake Qarun coast - Fayoum
5- Protection Ain Sukhna power station from the dangers of flooding
6- Construction dams in Suhag city - Dams to protect against the dangers of floods - Dams to protect from sand dunes
7- Construction of dams in Wadi Abadi - valley to protect against the dangers of floods in Aswan (In this project, a delegation from JICA visited us) and they expressed great admiration for the project and it is a national project.
Japan is one of the leading countries in building dams and protecting coastal cities using CSG method. Our company will be honoured to cooperate with any Japanese company in this field.
(CSG):

This method has already been applied to the construction of dams, auxiliary structures, and landslide control work, and has been used to construct two major dams, the Toptsu Dam and the Okukubi Dam.
The Okukubi Dam is the world's first trapezoid-shaped CSG dam, low cost for construction and reduces the burden on the environment. CSG is a new dam construction material developed in Japan to make the best use of materials produced near the site during dam construction.
One of the most important places I wanted to visit after the ISFF Kyoto University, Kyoto, Japan is the Okukubi dam in Okinawa Island.

Our company will participate in building dams in Wadi Abadi – Aswan from the National Projects in Egypt and we want to use this new method of (CSG) in building dams where it will be the first dams in Egypt used this way in construction.

**KEYWORDS:** Dam; against; floods; Wadi Abadi

Poster Code: SA-9

# *FLOODS IN MOROCCO: OVERVIEW AND EVALUATION BY THE SWOT METHOD*

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**ABSTRACT**

The Studies conducted on climate parameters observation series in Morocco have revealed the beginnings of climate change since 1971. The frequency of extreme events has been increasing and h become more and more common with high magnitudes. The phenomenon of flooding covers the whole territory (cities of Mohammedia, Settat, and Goulmim). . Beside to the aforementioned effects, the increase of temperature has influenced the regimes of streams whose watersheds receive snow. Indeed the snow melt is earlier, modifying the base flow and increasing the risk of flooding. On the other hand we note that under the effects of drought, the populations invaded the public hydraulic domains. As a result, the floods have caused greater damage faced with this alarming fact, Morocco has drawn up a national plan to fight against floods. The census carried out shows 391 flood sites of which 25 with high risk. On the urban level there are 50 cities that are threatened, 13 of which are large cities. Also it is mentioned that there is a great geographical disparity of these sites. Indeed the piedmont areas are the most concerned with floods that occur during the summer season, they are characterized by their due to sloped field and stormy rains. This observation is the result of the geomorphologic diversity combined with the different types of climate prevailing in Morocco, although it is almost entirety dominated by a semi-arid to arid climate. This study presents the conclusions of the SWOT (Strength, Weakness, Opportunities and Threat) method of the flood in Morocco. It shows that many efforts and actions were undertaken but there is lot of to do especially on the communication aspects and participative involvement. Such analysis would lead to (i) the improvement of the national plan to fight against floods (ii) the elaboration of an efficient strategy to mitigate the impact of flood with an emphasis on local and regional scales.

**KEYSWORDS:** Flood National Plan; Communication; Scales.

Poster Code: SA-10

# *MODELING THE IMPACT OF RIVER BED AGGRADATION ON THE INUNDATION SCENARIO IN AN UNGAUGED EPHEMERAL STREAM USING HYDROLOGICAL AND 2D HYDRODYNAMIC MODEL: A CASE OF BAKRA RIVER BASIN, NEPAL*

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**ABSTRACT**

Siwalik Hills of Nepal are geo-morphologically considered as the most sensitive regions of Nepal where the issues of soil erosion and land degradation are critical. Majority of the rivers originating from these hills are ephemeral in nature where the flow occurs only during the monsoon season. Flash floods are common in these rivers which tend to affect the channel morphology with every flood events. Furthermore, human-induced land-use change and haphazard construction work combined with extreme rainfall events have resulted in a significant increase in the sediment yield in the catchments of these rivers. High sediment influx alters the dynamic equilibrium of the channel causing higher deposition due to the reduced sediment transport capacity in the lower reach. Such processes have led to the continuous aggradation of the riverbed to such extent that the adjacent villages are now well below the river bed level at many places. Under such condition, the risk of flooding and consequent damage to the adjacent areas naturally increases. Riverbed aggradation due to excessive sedimentation has not only a negative impact on the river morphology but it also adversely affect the functionality of the flood mitigation structures. In this context, the current study tries to investigate the impact of such river bed aggradation phenomena on the extent of flood inundation in an ungauged ephemeral river which is a typical case of the above-mentioned problem. During the monsoon, channel shifting from one bank to another and embankment breach have been occurring every year even with medium flood events. In this respect, two recent flood events in the study area which led to the embankment breach and inundation of the village are used as base cases for setting up the model. We used the 1D hydrological model to generate the run-off from the rainfall events which in turn was fed as input for the 2D morpho-dynamic model. Inundation extent obtained from the field measurements and satellite images were used to validate the model predictions. Finally, the validated model was used for the impact analysis assuming two scenarios, 1m and 2m aggradation of the riverbed level and comparison is made with the base cases.

**KEYWORDS:** Soil Erosion; Bed Aggradation; Flash Floods; Inundation; River Training Works

Poster Code: SB-11

# *MOBILE-BASED EARLY WARNING SYSTEMS IN MOZAMBIQUE. AN EXPLORATORY STUDY ON THE VIABILITY TO INTEGRATE CELL BROADCAST INTO DISASTER MITIGATION ROUTINES.*

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**ABSTRACT**

Mozambique is one of the countries most affected by natural hazards in the world. Flash floods alone between the years 2000 to 2015 affected over 4.5 million people and destroyed 638,700 houses totaling up to nearly 690 million dollars in damaged infrastructure in the country where citizens are highly economically fragile. With natural hazards as one of its major problems, Mozambique can benefit greatly from enhancements on its early warning system. Cell broadcast, which is a technology able to transmit simultaneous alert messages to all mobile phones inside a geographic area, has gained increasingly attention of emergency authorities. Differently from SMS, which is a one-to-one transmission that requires the prior knowledge of the phone numbers of the people located inside the affected zone, Cell broadcast is one-to-many, area-based transmission, that allows the diffusion of alert messages to all mobile devices receiving signal from the coverage of surrounding antennas in the area to which an alert is issued. We compiled a map of the disaster risk management routines in Mozambique, interviewing the relevant institutions, to identify the currently in use warning systems and the availability of Cell Broadcast as a component of their early warning routines. It was possible to analyze the circuit of information from detecting a hazard and the pathway it takes until an alert is issued and transmitted to the target population. It was identified that there was no central system able to transmit Cell Broadcast directly from the emergency headquarters in Maputo. Nevertheless, engineers at major telecommunication operators reported willingness to cooperate with the emergency authorities to study a solution in which Cell Broadcast can be better used to strategically transmit alerts to target zones. Furthermore, the results also allowed to speculate on the feasibility of automated solutions in combination to the enhancements that Cell Broadcast can bring to disaster risk management routines and the possibility that other countries of similar profiles could also be benefiting from using this technology which might likewise be available in their current mobile infrastructure.

**KEYWORDS:** Cell Broadcast; Disaster Risk Management; Climate Change Adaptation; Emergency Response; Public Warning Systems; Flash Floods

Poster Code: SB-12

# *FUTURE CHANGES IN THE RAINFALL CHARACTERISTICS OVER INDIA IN MRI-AGCM GLOBAL WARMING EXPERIMENTS*

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**ABSTRACT**

The water-related disasters such as floods, coastal erosion, landslides, water hazards etc. over India have been a serious concern in recent decades. These disasters are mainly associated with the rainfall events and are strongly determined by the rainfall amounts, intensities and distributions over the target areas. In our study, we investigated these characteristics of rainfall over India in past 60 years (1951-2010) and their future changes in next 100 years (2051-2100 with 4K warming) by analyzing 190 ensemble experiment results (90 experiments for present climate and 100 experiments for future climate) from Meteorological Research Institute Atmospheric General Circulation Model (MRI-AGCM) simulations at 60km resolution (d4PDF dataset). We focused on the rainfall characteristics in two present-day climate periods (1951-1980 & 1981-2010) and their near and far future changes (2051-2080 & 2081-2110). The ensemble mean of spatial distributions of rainfall over India in present-day climate shows that the northeast India and few regions over southern India experienced more rainfall during 1951-2010. The Asian Precipitation Highly Resolved Observational Data Integration towards Evaluation (APHRODITE) daily observations also shows the same amount of rainfall over those regions. The rainfall events in future warming climate are expected to bring more precipitations over almost all regions of India. The northeast region and southern regions of India are likely to experience stronger rainfall events in future warming climate. The intensity and frequency of the stronger rainfall events (>20 mm/d) over India (areal average) are also likely to increase in future warming climate. Each ensemble experiment results show the same characteristics of frequency and intensity for near and far future changes. The annual cycles of the rainfall climatologies indicate that the rainfall intensities in future warming climate are like to increase especially during July-October month. We find that the increase of rainfall intensities over India could be associated with stronger upward motion of air and more availability of specific humidity under future warming climate. Overall results suggest that the water-related disasters over India will be more severe and may cause local flooding and landslides in future warming climate.

**KEYWORDS:** Climate Change; d4PDF; Annual cycle; Ensemble experiment

# Session B

Poster Code: SB-1

# *ASSESSMENT OF SEDIMENTATION USING FIELD INVESTIGATION AND UAV IMAGING AT ASSERIN UPSTREAM DAM, WADI MIJLASS, OMAN*

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**ABSTRACT**

Monitoring the sediments coming from upstream reaches in Wadi basins during the flash floods is extremely difficult and missing in arid regions. There has been little attention paid to the sedimentation assessment and impacts associated with flash floods in arid regions, especially in the Arab regions with hyper aridic conditions. Several studies highlighted the importance of sediment monitoring during flash floods to operate and take countermeasures in recharge dams, but the sediment observations are not recorded and documented adequately. Accordingly, the main objective of this study is to understand and assess the sedimentation issues in arid Wadi system. This study focuses on finding the relation between the sediment volume and the extreme flash flood events. Therefore, the field survey such as UAV surveys, Pedon analysis, sediment measurement bars were conducted to calculate sediment volume in the reservoir. Four field surveys on Dec. 2017, Sep.t 2018, Mar. 2019 and Aug. 2019 were conducted for Wadi Asserin Dam in Oman in order to investigate and measure the sediments at Asserin up Dam, Wadi Mijlass. The study area has nineteen measurement bars distributed within the reservoir area used to monitor the sediments. Topographic data from UAV imaging help in understanding the distribution of sediments along the reservoir because the high resolution developed DEM. The sedimentation volume at the reservoir was calculated from the sedimentation measure bars which already installed in the reservoir before the dam constructions. Also, the sediment thickness in the reservoir was estimated based on the identified sediment layers (from 2011 to 2017) at the three Pedons conducted in the field surveys on Dec. 2017.The sedimentation volume was estimated about 37198 m3, which was accumulated over 9 years (From 2011-2019). The field survey results showed that the trapping efficiency for Asserin upstream dam decreased by about 4%. Currently, we are trying to develop another approach to estimate the sediment volume using the Interferometric Synthetic Aperture Radar (InSAR) technique.

**KEYWORDS:** Flash flood events; Sedimentation; Wadi systems; Field survey; UAV imaging; InSAR

Poster Code: SB-2

# *RAINWATER HARVESTING, A SOLUTION TO FLOODS IN KIGALI*

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**ABSTRACT**

Nyabugogo Valley is located in the west side of Kigali city, the capital of Rwanda. Its steep catchment area on the foot of Mt. Kigali and Mt. Jali holds high population density, excessive land use, markets, a lot of buildings and activities. During the rainy seasons (twice a year), due to its topographic characteristics and urbanized land cover, flash floods often occurred with severe inundation damage on the commercial area on the lowland along the river, opposite to the swampy riverbank used for agriculture.

On the other hand, the available water resource is not sufficient for the expanding water demand with the high population growth (2.63 % in 2018) and the hilly extent of the urbanized area restricts the water supply network. Alternative water supply system is required for the improvement of the quality of life in the catchment area.

This study aims to propose an on-site rainwater harvesting system that is economically affordable, producing a good quality of water and able to solve the flood issue sustainably in Nyabugogo valley. Return period of the precipitation in Nyabugogo catchment was estimated. The volume of the storage was estimated based on the rainfall time series and water demand of each household.

This research will contribute to the population's health and sanitation improvement by providing easy access to clean water and reducing water cost. The devastating impacts on human and infrastructures caused by flooding will be reduced. This study will also contribute to elaboration of policies, strategies and regulations regarding flood risk reduction for proper environmental planning and management. This will be another step towards achieving the 6th SDG (Sustainable Development goals), which is to ensure availability and sustainable management of water and sanitation for all.

**KEYWORDS:** Flood; Drainage System; Rainwater Harvesting; Precipitation Data; Catchment

Poster Code: SB-3

# *PHOTOGRAMMETRY ANALYSIS APPROACH TO QUANTIFYING THE POST-FLOOD PEAK DISCHARGE IN THE ARID REGION, CASE STUDY IN SULTANATE OF OMAN*

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**ABSTRACT**

Monitoring and quantification of flash flood in the arid region is quite a challenge to be managed and developed due to the large-scale catchments and the financial investments in the water sector. The poorly understood feature of hydrological processes was associated with the limitation of flash flood data in the arid region. Although, several wadi channels in most of basin are ungauging stations. However, flash flood is one of water resource should be harvested and managed to provide dominant sources of recharge to the groundwater system. The slope area method is a conventional technique used to quantifying post-flood discharge in wadi system, which has some uncertainty and required time and equipment for surveying. Therefore, the observation and field measurement will assist to obtain baseline data for resources assessment and observe variations that may occur.

With high growth of technology of Unmanned Aerial Vehicles (UAV also known as drones) and utilized them as instruments, which are used to extract some information such as channel morphology and flood marks. In this paper, we present a novel technique for quantifying the post-flood peak discharge in wadi system, using imagery acquired by UAVs with photogrammetry analysis. The approached method use field survey data and the digital elevation model (DEM) data products of UAV photogrammetry. The DEM was constructed based on formulation of textural features and detection of the structural properties with differentiation of features with similar spectral in the same region. The method was applied to the flash flood that occurred in May 2019 in the Wadi Aluqq, Ad Dkaliah region, Oman. The post-flood discharge was reconstructed from the manning equation within the range of the conventional methods and low uncertainty.

**KEYWORDS:** Flood; Discharge; Monitoring; UAV; Arid Region

Poster Code: SB-4

# *STRATEGIC ENVIRONMENTAL ASSESSMENT PROTOCOL FOR BETTER FLOOD MANAGEMENT PLANNING IN KABUL BASIN*

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**ABSTRACT**

Afghanistan as a land locked mountainous country of only 12% agricultural lands where as merely 6% is underutilization is "among 36 countries of Asia and Pacific in the context of water related disasters" . Kabul basin (tributary of Indus Basin) as the important transboundary basin among 5 basins of Afghanistan with a catchment area of 92,605 km2 , is flash flood prone area with several tributaries (4 main,5 submain) originating from various peaks of Hindu Kush Mountains. Those various flows through valleys and paths where thousands of inhabitants and Agricultural lands are endanger of flood occurrence.

The Government funded by the World Bank executes the flood control programs for decreasing the ferocity and damages with the constructions of river bank protection with gabion boxes, retaining walls and some check dams along the river streams. However, these are temporary expedient, not a Pre-Planned approach towards this phenomena. Therefor the Strategic Environmental Assessment (SEA) Protocol is highly considered to be a platform towards a better flood management plan, policy and strategies in Kabul Basin.

In order to follow Strategic Environmental Assessment Protocol for better Flood Management Planning (FMP) in Kabul Basin, the topographic and hydrological characteristics of each tributary were surveyed. DEM and Multiband satellite images gave the understanding of the sub-catchments.

**KEYWORDS:** Kabul Basin, Flash Flood, SEA Protocol, FMP

Poster Code: SB-5

# *IMPACTS OF URBAN GROWTH, EXTREME CLIMATE, AND DISASTERS MISMANAGEMENT ON FLASH FLOOD VULNERABILITY IN EGYPT*

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**ABSTRACT**

Urban growth, extreme climate and mismanagement are crucial controlling factors that affect the flood vulnerability at wadi catchments. Therefore, this study attempts to understand the impacts of these three factors on the flash flood vulnerability in different climatic regions in Egypt. An integrated approach is presented to evaluate the urban growth from 1984 to 2019 by using Google Images and SENETINEL-2 data to develop hazard maps by using a rainfall-runoff inundation model (RRI). Annual rainfall trend analysis was also performed to evaluate the temporal variability trend. The created hazard maps were classified into three categories (low, medium and high) and integrated with the urban growth maps to evaluate the impacts on the vulnerable areas for flood hazards. The results show a significant increase in urban growth resulting in an increase of the prone areas for flood hazards over time. However, the degree of this hazard is mainly related to growth directions. Mismanagement affecting on urban growth directions in both planned and unplanned growth, whether by Loss of control over unplanned growth or by deficiencies in approved plans. The rainfall analysis showed that there is no explicit relation with increasing or decreasing the flood vulnerable areas. An urban planning approach is recommended for risk reduction management based on a comprehensive study considering these controlling factors.

**KEYWORDS:** Floods Vulnerability; Hazard Maps; Urban Growth; Disasters Mismanagement; Extreme Events

Poster Code: SB-6

# *RAINFALL-RUNOFF-INUNDATION IN A DATA-SCARCE FLASHY WATERSHED: AN APPLICATION IN KANDRA RIVER BASIN, NEPAL*

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**ABSTRACT**

Terai region, a granary of Nepal, is prone to flooding and inundation. Kandra River (KR) is a flashy river having very low flow during the dry periods. But, upon heavy rainfall, floods develop quickly with little warning, resulting in disastrous consequences for communities. Almost 85% of rainfall occurs in the monsoon period, which spans from June-September. The elevation of the KR basin ranges from 140m in the south to 1750m in the northern part. With the complex topography and climate, flash floods are frequently occurring. The hydrological and hydrodynamic modeling with 1-day rainfall and mean daily discharge would not replicate the real scenario. This study has attempted to assess the responses of the basin with different patterns and magnitudes of rainfall. Due to the lack of real-time/hourly interval rainfall information in the study area, we have employed the unit-hydrograph approach for rainfall-runoff analysis. Snyder's method has been used which is one of the most commonly used methods. Three virtual rainfall hyetographs (fore, center and rear intensity rainfall) are then developed for different return periods. A 2-D shallow-water unsteady flow model is used to simulate runoff-inundation. The calibrated Snyder coefficients Ct and Cp for KR Basin ranges from 0.49-0.59 and 0.35-0.37 respectively. It is found that for the rainfall of higher return periods, the rear intensity pattern produced greater inundation area whereas, for the lower return periods, the center intensity did. The areal extent of inundation due to the rainfall of return periods 50 years is almost similar to other higher return period's rainfall with a slight variation during the time of peak.

**KEYWORDS:** Rainfall-Runoff-Inundation; flash flood; return period

Poster Code: SB-7

# *SPATIAL AND TEMPORAL VARIABILITY OF EXTREME RAINFALL INDICES IN NORTH-EAST OF ALGERIA*

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**ABSTRACT**

Algeria, as a Mediterranean country, has undergone severe climatic changes during the last decades in terms of rainfall. The media coverage of such events as the floods has led to a perceived increase in extreme rainfall in Algeria. However, no coherent signal has been detected in the variables describing these phenomena (floods). This can be explained by the fact that the rainfall series are by nature subject to high natural variability. A climate index is defined as a calculated value that can be used to describe the state and the change in the climate system. Climate indices allow a statistical study of variations of the dependent climatological aspects, such as analysis and comparison of time series, means, extremes and trends. In this paper the Spatial and temporal changes in rainfall indices are analysed for the north-east of Algeria. An analyze of rainfall data is done for a period of more than thirty years (30 years) on fourteen rain gauge stations (14) located on north-eastern Algeria. The data is obtained from the National Agency for Hydraulic Resources (ANRH). Extreme indices were calculated on the basis of the daily rainfall using an approach recommended by the expert team on climate change detection and indices (ETCCDI). We made various statistical analyses using R packages: RClimDex, Rhtests and Statpro software. The database was sorted and structured several times in order to be usable by these software. The study result shows an increasing trend in most of rainfall station in our study area. The eleven extreme precipitation indices are calculated using the RClimdex R package. Then, we applied Rclimdex for the computation of the eleven indices characterizing the extreme precipitations namely CDD, CWD, PRCPTOT, R10, R20, R50, R95p, R99p, RX1day, RX5day and SDI, as well as their tendencies. A large number of stations are experiencing significant downward trends. The dry Sequences recorded at most rainfall stations showed only negative trends. Most of the rainy sequences recorded at the 14 stations show a significant downward trend. A decrease was observed in the total annual rainfall in wet days. The annual number of days with rains exceeding 10 mm, 20 mm and 50 mm shows a downward trend in the majority of the stations selected, which shows that the study area has a prevailing dry climate, for periods of observation of each station. An important downward trend has been identified for very wet days R95 and extremely wet days R99 in more than 76.6% of all rainfall stations The monthly maximum 1-day rainfall and monthly maxi-mum 5-day rainfall show a similar decreasing trend such as only 12 stations out of 14 that reveal this decrease for RX1day and all stations for RX5day. From these results we conclude that climate change is real and this variability in the extreme rainfall indices proved it.

**KEYWORDS:** climate change; ETCCDI; rainfall extreme indices; Northeastern Algeria; RClimDex

Poster Code: SB-8

# *RISK OF COASTAL FLOOD ON THE ATLANTIC SEA, MOROCCO*

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**ABSTRACT**

The Azemmour site, on North Atlantic coast of Morocco is very vulnerable as are all Moroccan coasts subject to long ocean swells. Indeed, many phenomena occur in this area such as predominant astronomical tide, storm surges and marine submersions occurring at extreme sea levels.

The risk of flooding by the sea is currently high on this coast, particularly in areas where coastal dunes undergo anthropogenic disturbances. The Marine submersions occur when specific meteorological conditions, atmospheric depression sea wind, and high coefficients tide gauges concur. Azemmour has a particular configuration: a strong degradation of sand dunes chain is observed because of the informal sand exploitation along with natural coastal erosion due to the bathymetric configuration and the continuous evolution of the coastline.

The definition of the reference event will subsequently characterize the marine submergence hazard on Azemmour. After the diagnosis, it was highlighted that significant damage following the storm of 07 January 2014 took place.

A numerical modeling of the coastal swell coupled with models for storm surge forecasting is presented. The major parameters that have been used are shown and the results are discussed in this work.

**KEYWORDS:** Azemmour (Morocco); Risk of coastal flood; Numerical modelling; Coastal waves

Poster Code: SB-9

# *INVESTIGATION OF SLUICE GATES IN ENERGY DISSIPATION THROUGH HYDRAULIC JUMPS*

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**ABSTRACT**

Hydraulic jumps often occur in natural open channels as well as artificially constructed channels as a result of an abrupt transition from supercritical to subcritical flow, for example the flow at the toe of spillway. Hydraulic jumps are applied by engineers to dissipate energy to protect downstream structures from scour and also erosion of river banks. Sluice gates are devices that are commonly used to control the water levels and flow rates in the channels for irrigation and wastewater treatment purposes, and can also be used to generate hydraulics jumps. While there have been a number of studies on the relation between sluice gates and its effectiveness to generate hydraulic jumps, there is a lack of research on how the change in conditions of flow, channel bed and relative location of sluice gate effects the performance hydraulic jump. Furthermore, the application of sluice gates in Oman is not yet practiced by engineers (for example Dayqah dam). Particularly, countries in Middle East experience flash floods which cause overflow of natural and artificial channels resulting in environmental and social consequences in the country. To properly design flow control structures such as sluice gates requires some in depth study on the variables which effect the performance of the hydraulic jump. To address these issues, this study is aimed at investigating the ability of sluice gates to generate the hydraulic jump and maximum energy reduction. Experiments were conducted in a pilot sized 2.5m hydraulic flume in the fluid mechanics laboratory at Military Technological College (MTC), Oman. A sluice gate was installed in the channel and various hydraulic jumps were generated by changing the hydraulic parameters such as the flow rate, slope of the channel bed, and relative position of the sluice gate. The energy dissipation caused by the hydraulic jump was measured. It was observed that energy dissipation of the hydraulic jump had increased as the flow rate was increased. The rate of energy dissipation was low initially smaller flow rates, but increased abruptly as the flow rate crossed a threshold value. As the sluice gate was positioned further away from the water source (reservoir), the rate of energy dissipation had reduced. Also, the dissipation levels occurred slower over the range of flow rates studied. Only at very high flow rates, the dissipation rate increased abruptly. When increasing the gradient of the channel bed (positive slope), it was noticed that the hydraulic jump occurred further away from the sluice gate. In addition, the energy dissipation was reduced as the channel slope was increased. Further curve fitting analysis were performed to establish parametric equations to describe the effect of each of the parameters on the energy dissipation level.

**KEY WORDS:** Hydraulic Jump; Energy Reduction; Hydraulic Structures

Poster Code: SB-10

# *INNOVATIVE STRATEGIES FOR INTEGRATED RIVER BASIN MANAGEMENT AND RESERVOIR SEDIMENTATION IN TUNISIA: CASE STUDY OF SIDI SALEM DAM*

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**ABSTRACT**

Surface water in Tunisia; makes up 55% of the total water resources in the country. These resources are being subject to a qualitative and quantitative deterioration mainly due to high sediment yield and pollution caused by the ever-increasing anthropogenic activities. 25 % of these resources are being mobilized by Sidi Salem reservoir alone. Sidi Salem drains 80% of the madjerda watershed, making it the largest embankment dam in the country. However, during the last decade Sidi Salem's Sedimentation has reached its peak, drastically reducing its retention capacity, thus impairing its function, as well as affecting the natural flow of the Majerda River and its effluents .This accelerated alluvial deposition can be traced back mainly to the increased soil erosion rates and to the management policies of the reservoir itself. Accordingly, establishing an efficient mitigation approach for Sidi Salem's sedimentation will ensure a better sustainable water development, thus not only restoring the structure's function but also insuring its resilience. The main goal of this research is to set up a robust 3D Flow and Sediment Transport model for Sidi Salem Reservoir which will be used to assess different flushing scenarios from which the most efficient and reliable scheme for sediment flushing will be identified. The methodological approach for this research will be based on literature reviews, site surveys, data collection and numerical modeling. The first step of this study will consist of a thorough review of alluvial deposition in reservoirs and its features as well as the various techniques applied to mitigate it, in general, and sediment flushing in particular. Next sediment dynamics in Sidi Salem dam will be outlined through the reinterpretation of available Bathymetric surveys and analysis of other available data. Then Turbidity currents as well as rainfall-runoff relationship will be modeled, through the use of satellite imagery and other meteorological data. This step would serve for the preparation of boundary conditions for the TELEMAC3D model. In the second stage of this study a 3D model will be established using TELEMAC3D or SSIIMM3D .Once Calibrated and verified this model will be used to assess different flushing scenarios. Several approaches for increasing the flushing efficiency will be examined through modifications of flow and reservoir operation rules (i.e., soft measures), and through the implementation of some construction works (i.e., bypass tunnel, diversion weirs, flow guiding structures or longitudinal auxiliary channels) to affect the flow patterns (i.e., hard measures). The most potent scenario in terms of economical efficiency and environmental sustainability for Sidi Salem reservoir will be proposed.

**KEYWORDS**: Surface Water Resources; Madjerda Watershed; Sedimentation; Bathymetry; Flow And Sediment 3D Modelling; Water Management Strategy; Flushing; Alluvial Deposition; Turbidity

Poster Code: SB-11

# *EXPERIMENTAL STUDY FOR INFILTRATION MODEL CHOICE: CASE OF MADJEZ RESSOUL CATCHMENT.*

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## ABSTRACT

The physical phenomenon, in which water penetrates into the soil from surface sources is known as infiltration. Knowledge of infiltration is important not only for controlling the flood risk from permeable surfaces but also for the subsurface flow, the storage of the water table in watersheds, and in the field of irrigation and agriculture. When we deal with long term studies, knowledge of infiltration is very essential because it separates the water into two parts: surface flow and groundwater flow. Infiltration rate depends on several parameters include the moisture content, texture of soil, density and behavior of the soil. Because of this fundamental role, infiltration has received a great deal of attention from soil and water researchers. Theoretical models based on physical aspects and derived from hydraulic and physical principles of the mass conservation and Darcy's law have been asses. This type of models requests usually infiltration measurements. The objective of our research is to determine the infiltration rate of soil for Madjez Ressoul catchment (Northern Algeria) using a double ring infiltrometer which has two parts: one was outer ring600mm, and second was inner ring whose diameter is 300mm. Both rings were implemented 50 mm depth without disturbing the top soil surface. The methodology consists to inject constant volume of water in both rings at the same time and measure the infiltrated volume of water, during many regular intervals of time (2min), expressed mostly in cm/h, and plot the mean incremented velocity against time, until a constant rate of infiltration for all points. The initial and final infiltration values from 26 points over an area of 103 ($km^2$) were used to estimate after that the best performing linear regression of Horton's model. Attempt was made to evaluate this infiltration equation on the basis of experimental data of the study area and to obtain numerical values for the parameters of the model. To determine the moisture, different samples of soil have been tested in laboratory. Where the dry soil in each point was placed in small sampling bags before the application of infiltration measurements. The time required to dry soil samples was about 24 hours in a Vacuum drying oven to ensure a precise and reliable temperature control. The obtained results show a best fit of $R^2$ parameter more than 0.9 in all cases. Such results will be compared to other models of infiltration to extract the appropriate model of infiltration for Madjez Ressoul catchment.

**KEYWORDS:** Infiltration rate; Double ring infiltrometer; Coefficient of correlation; Horton's model Events

Poster Code: SB-12

# *FLOOD RISK MANAGEMENT IN THE N'FIS WATERSHED OF THE HIGH ATLAS - MOROCCO: HYDROLOGIC AND STATISTICAL MODELLING FOR FLOOD FREQUENCY ANALYSIS*

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**ABSTRACT**

The recent flash floods that occurred in different regions in Morocco in August and September 2019 have caused serious human and material losses that will permanently mark the collective memory of Moroccan citizens. Hence, a forecast, both reliable and early-intervening, may limit the aftereffects of such events. It helps sensitize decision-makers to the danger posed by climate hazards, uncontrollable urbanization and reduce their vulnerability by integrating the different methods of flood forecasting into natural hazards prevention strategies. In this study, the N'fis watershed (1822 $km^2$) was selected considering its location. It's a sub-basin of Tensift watershed of the High Atlas Mountain next to Marrakech city. This mountainous region is much known for recurrent and violent floods with high magnitude. As flow simulation at the outlet of a watershed is an essential step for the management of water resources, especially for flood forecasting, a hydrological model using SWAT (Soil and Water Assessment Tool) was suggested. It's a physically based model, computationally efficient and, capable of continuous simulation over long time periods. Major model components include, among others, weather, hydrology, soil temperature and properties and land use. The tool is able to take into account the different important factors that impact the floods in a rural area. In order to test the performance of SWAT and the feasibility of using this model as a simulator of flow in the studied watershed, three quantitative statistics, namely Nash-Sutcliffe efficiency (NSE), percent bias (PBIAS), and ratio of the mean square error to the standard deviation of measured data (RSR), in addition to the graphical techniques, were used in the model's evaluation. One of the most common techniques to estimate the recurrence of high magnitude floods is the flood frequency analysis. Statistical methods, namely Gumbel Normal and Log Pearson III, were applied to the daily flood frequency generated by SWAT simulation, which can produce results of hourly frequency. From this procedure, two of most commonly used distribution methods, Gumbel and Log Pearson type III are evaluated. The analysis is done for 5-, 10-, 25-, 50-, and 100-year return periods by using annual maximum discharge data from 1982 to 2018 (37 years).

**KEYWORDS:** Flood Frequency; Vulnerability; Hydrological Modelling; SWAT Model; Gumbel; Log Pearson Type III

# Other Submitted Abstracts

# *THE RUNOFF AS A SOURCE OF NATURAL RECHARGE OF THE GROUNDWATER AQUIFERS IN THE SULTANATE OF OMAN*

## *(A CASE STUDY FROM GONU CYCLONE)*

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**ABSTRACT**

The water resources of the Sultanate occur in two ways, either groundwater which is represented by wells and daudi type of aflaj or surface water, which is represented by the ghaily type of aflaj, springs, and few perennial wadis. Many of the wadi channels starts from high mountains where the channels are narrow with less alluvium however as they precede downstream to the sea the alluvial plains are formed and therefore the recharge becomes more effective. The average wadi flow reaches about 211 Mm3 /year. This paper focuses on the role of runoff in recharging the groundwater aquifers.

Groundwater is the main source of water use representing 92 % of the total renewable water resources. Data and information obtained from the Gonu cyclone (2007) were used in order to estimate the amount of groundwater recharge after the event. During this event, a rainfall depth of 240 mm fall over the study area (within the first 24 hours) which is more than two and half the annual average of the country. Wadis in arid areas such in Oman play a very important role in recharging the ground water aquifers. As there are very few studies on recharge of the aquifers in arid countries such as Oman it is recommended that more studies be done. These studies will help the hydro geologists, engineers and decision makers quantifying the water available within a given aquifer and whether an artificial recharge such as construction of dams is needed.

**KEYWORDS:** Wadi Flow; Alluvial Plans; Aquifer Recharge; Gonu Cyclone; Oman

# *WATER GOVERNANCE AND CLIMATE CHANGE IN THE SOUTH PART OF JORDAN*

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**ABSTRACT**

Starting in 2012, established a real time water-monitoring network in the Lower Jordan-Dead Sea basin. The station network includes water quantity, quality, and weather and web camera stations located on the Jordan River, Dead Sea, and Wadi Mujib and in the Karak Highlands (Mutah University). Data is reported to a centralized command centre and published through the project website. Jordan is one of the most water stressed countries in the world in a region where water scarcity is a fact of life. Jordan shares significant transboundary surface and groundwater resources with Israel, Syria, Egypt, the West Bank and Saudi Arabia. These limited, and in some cases, un-renewable water resources support a multitude of strategically important water uses such as drinking water, irrigation, industry, tourism and aquatic life. The availability of adequate quantity and quality water in Jordan is deteriorating over time due to a number of factors such as rapid population growth, rapid urbanization, limited water resources, unsustainable water use and degradation of water quality. Additionally, climate change and associated impacts such as changes in precipitation patterns, increased frequency of droughts and floods and high evaporation are affecting the availability of water resources. In order for Jordan to make informed decisions in the areas of transboundary water governance and climate change, it is essential that a state of the art data collection network with adequate spatial coverage be established, operated and maintained. Data from this new network of stations will be used to help water resource managers understand the responsiveness of parameters to different impacts, the status of water resources and trends over time. The implementation of the water monitoring network and development of extended water resources application tools will help build capacity for water resources management in Jordan. The monitoring network also provides a forum for regional cooperation and information sharing, which is the first step towards integrated transboundary water resources management and maintaining water peace in the region through transfer of technology and knowledge.

**KEYWORDS:** Real time; water quality; data collection network; water governance.

# *COMPOSITION AND SEDIMENTOLOGY OF QUATERNARY ALLUVIAL FANS IN WADI BIH, RAS AL KHAIMA, UNITED ARAB EMIRATES*

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**ABSTRACT**

The United Arab Emirates (UAE) is located in an arid climatic zone with sparse rain (average 110 mm/year) and is hence dominated by desert landscape covered largely by sand dunes and barred mountains that are cut by a series of thrust faults. Clastic deposits made up of gravel intermixed with sand and mud dominate the alluvial fans and plains adjacent to the mountains. Deposition of the up to about 100 m thick alluvial fans, which are fed by intermountain valleys aligned along faults (developed as consequence to the Zagros orogeny) that cut through uplifted carbonate deposits ranging in age from Perm-Triassic to Cretaceous, occurred during the past ca 100 kyr. Poorly sorted (boulder to silt size) alluvial fans deposits resulted from flash flood events and hence display sedimentary structures and grain size distribution that reflect mass (debris) flow (massive bedded, poorly sorted). Furthermore, intermittent fluvial processes showing imbrication of the pebbles and trough cross bedding associate the fan deposits. Dominance of limestones resulted in flat, well-rounded grain texture in the alluvial fans. Depositional facies include proximal, medial and distal fan system in environments ranging from proximal shallow stream and sheet floods, channelized non-cohesive debris flows, and distal silt/mud sheets. No sabkha evaporates were recognized within the alluvial fan deposits. Gravel-sized limestones in the lowermost part of the alluvial fans display evidence of stronger dissolution (i.e. interaction with rain water) than in the upper part, probably owing to wetter climate in the past. The uplifted carbonate successions also display varying extent of karstification. The dissolved carbonate mass has re-precipitated as calcite cement, which resulted in partial lithification of the deposits. The presence of small amounts of silica cement (opal) in the alluvial fan suggest derivation from the dissolution of wind-derived siliciclastic sediments, which are typically encountered in the upper part of the alluvial fan cycles.

**KEYWORDS:** Alluvial fan; facies; composition; arid climate; wadi

# *MEASURING VULNERABILITY TO FLASH FLOOD FOR URBAN INHABITANTS: A CASE STUDY OF DHAKA MEGACITY, BANGLADESH*

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**ABSTRACT**

Recently, catastrophic hydro-meteorological hazards (such as flood) are occurring frequently over the world. However, flash floods are unexpected, localized flood events that occur when an exceptional amount of rain falls over a short period of time (a few hours to days) within a catchment producing a rapidly rising and fast-moving river flows. The flash floods in South Asia is mostly disastrous, for example, in 2017 flash floods killed approximately 1200 people from India, Nepal as well as Bangladesh. However, hydro-meteorological hazards, mainly flash floods, are common in Dhaka, the capital of Bangladesh. Due to its geographic location, monsoon climatic condition and surrounding rivers (the *Buriganga* to south and the *Turag* to north and the *Balu* to west). Flash floods in Dhaka are common and generally occur in early monsoon time (April-May). Though it is impossible to avoid them, but the losses and damages of hazards can be reduced effectively by using appropriate techniques. This study aims to determine the factors responsible for people's vulnerability to flood and measure household vulnerability to flash flood as a tool of mitigation. The study has been conducted based on primary data. Therefore, data were collected from both slum and non-slum population to cover the entire urban habitats and to make comparison the level of flash flood vulnerability of them. Data were collected with structured questionnaire based on five factors (social, economic, institutional, structural and environmental) of vulnerability to flash flood. The study also identified and evaluated the responsible factors, those create household vulnerability to flash flood in Dhaka megacity. The key feature of this paper is to provide an insight of real picture of vulnerability to flash flood for urban habitants (both slum and non-slum). Moreover, this practical approach is useful to quantify hazard-induced vulnerabilities not only for Dhaka but also for other cities all over the world. However, based on the findings of the results some recommendations for reducing people's vulnerability to flood have been proposed.

**KEYWORDS:** Flash Flood; Factors of Vulnerability; Urban; Slum; Non-Slum; Dhaka megacity.

# *ESTIMATING THE SEDIMENT YIELD OF ARID WATERSHED FLASHFLOODS INTO THE NILE RIVER IN EGYPT*

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**ABSTRACT**

With the rapid progression in climate change, an increase in flashflood events is expected. Despite a significant progress in the modeling of sediments in agricultural watersheds, there aren't as many studies on the estimation of the sediment yield from arid lands. This can be attributed to the lack of on-ground measurements and observations. The present study is focused on a significant flashflood event near Sohag in October 2016 yielded a significant amount of sediment which flowed into the Nile River. Following this event, several navigation units grounded along the navigational path at choke areas along the Nile River in Egypt affecting tourism and economy. A modeling study aided with remote sensing data was carried to estimate the sediment volume discharged into the Nile River. Hourly rainfall depth was collected from GPM data set for the estimation of surface runoff. Remote sensed soil type maps for the watershed understudy were used to estimate curve numbers and determine the sediment size classes to be used in the sediment load calculations. The watershed modeling system solver (WMS) was used to depict the streams and estimate the amount of surface runoff at the outlet of each sub-basin. A 2D land evolution model (CAESAR-LISFLOOD) was later used to calculate the sediment yield in watershed. CAESAR-LISFLOOD was calibrated to produce the same amount of discharge at the watershed outlet. An attempt was made to validate the modeling results with remote sensing of bathymetric changes in the Nile River. The study presented focuses on the importance of monitoring and modeling of the flash floods and its impact on the Nile River.

**KEYWORDS:** Flash flood; Sediment Yield; Nile River; Arid Watershed

# *ASSESSMENT OF THE ALOS-PALSAR 12.5 DEM FOR WATERSHED ANALYSIS IN DESERT ENVIRONMENTS*

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**ABSTRACT:**

Flash floods have become frequent due to weather extreme anomalies in arid regions. Digital Elevation Model of good quality is deemed a basic input to simulate flooding and to assess flood risk-prone areas. In the present research, the effectiveness of the Advanced Land Observing Satellite Digital Elevation Model (ALOS DEM) for watershed analysis is investigated. The DEM resolution impacting the accuracy of the feature extracted and the watershed morphometric parameters (e.g., boundary, sub-basin, stream networks, flow line intensities, etc.) is assessed through visual observation of data overlay and field observation and measurements. The results proved promising capability of the ALOS DEM for watershed analysis and used to update the hydrographic maps and support the environmental management of the flood risks and water resources in the arid environments compared to the DEMS freely available from other sources at various resolutions.

**KEYWORDS:** Flash floods, Catchment, ALOS DEM, Accuracy assessment.

# *FLASH FLOODS AND GROUNDWATER OCCURRENCES IN WADI SYSTEMS CONVOLUTED BY THE GEOLOGIC AND TECTONIC DEVELOPMENT OF THE RED SEA MOUNTAINS IN EGYPT.*

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**ABSTRACT:**

Flash floods often devastate the coastal areas in the Red Sea in Egypt, which are mainly developed for resorts and tourism activities. The high relief- basement rocks underwent regional geological episodes of intrusion, deformation, uplifting and development of local sedimentary basins. As a result the wadi systems are also of complex longitudinal profiles; acute intersections, and structural offsets are usually common. Therefore, the accurate insertion of catchment boundaries are fraught with great deal of uncertainty, as the watershed divides can dissect some wadi stretches that witnessed reverse of original flow directions driven by geologic and tectonic evolution of the Red Sea massif. The automatically extracted drainage networks from the available SRTM DEM were compared with their counterparts on a satellite image shortly acquired after a regional flash flood event in the area, which clearly shows the opposite flow directions of active channels located in single well-defined wadi course. The estimated surface extent of these unique catchments were then used to estimate the quantitative parameters of flash floods using the GIS-based spatially distributed unit hydrograph method of Maidment (1993). The geophysical measurements using 1D and 2D techniques showed that the occurrence of partially saturated alluvium are controlled by geological structures, which have developed local subsurface troughs than surrounding. The geological deposition of Miocene limestone on the coastal footslopes of the Red Sea Mountains has also blocked the groundwater in numerous wadis from being discharged into the sea. The integrated surface and subsurface hydrological assessment of the dryland wadis debouching in the sea allowed the optimum identification of most suitable places for harvesting runoff and replenishment of the fragile groundwater aquifer specific locations. The wider implication of these findings is to decipher the complex geologic evolution of drainage basins in ergogenic belts, to better mitigate the flash floods and to explore and develop groundwater resources.

**KEYWORDS:** hydrology; subsurface; aquifer; GIS; remote sensing; geo-electric

# *CLIMATE STRICKEN; CHALLENGES OF FLOOD MITIGATION IN BANGLADESH.*

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**ABSTRACT**

Bangladesh is a riverine country and one of the most flood-prone countries in the world with the greatest risk of being affected by climate change and natural disasters like Flood, Cyclone, Landslide and Lightening. Some 30 to 35% of the total land surface of the country is flooded every year and people use multiple strategies to live with flooding events and associated riverbank erosion. They relocate, evacuate their homes temporarily, change cropping patterns, and supplement their income from migrating household members. The frequency and intensity of natural hazard are increasing day by day parallel to the climate change. The image of Bangladesh as a country that is adapting well stems from its long history of living with floods. Every year the country has been losing a large part of GDP as an economic loss. Regular floods are part of people's lives, recurring with varying magnitudes and frequencies to which people have adapted. Bangladesh experiences four different types of floods: flash floods, riverine floods, rain floods and storm-surge floods. Floods and cyclone are some of the most destructive hydro meteorological phenomena in terms of their impacts on humans, infrastructure, and economic sectors and also ecosystems in Bangladesh.

The Flood Forecasting and Early Warning system is also equipped with experienced and trained personnel. FFWC is capable of issuing forecasts 30 to 72 hours in advance using real time data. In Bangladesh, flood forecasting and warning is conducted with the aid of a hydrological and hydrodynamic mathematical model (MIKE11-GIS) and the NOAA–AVHRR satellite imagery and processing system. The geotechnical work involved in upgrading the embankments to mitigate the flood situation. Soil are used to increase the height and width of the embankments, locally produced concrete blocks or geo-tubes are offer slope reinforcement. In addition to the geotechnical work, sluice gates associated with the existing embankments and their respective drainage channels are being updated. This is now agricultural requirements for the use of the sluice gate," The new sluice gates incorporated into the embankments and sliding gates that is enabling the sluices to function in both ways so that they can be used as part of local water management operations.

The flood problem in Bangladesh is extremely complex. The country is an active delta; it has numerous networks of rivers, canals and coast creeks with extensive flood plains through which surface water of about 1.7 million sq-km drains annually. Although the livelihood of the people in Bangladesh is well adapted to normal monsoon flood, the damages due to inundation, riverbank erosion or breach of embankment, etc. still occur in almost every monsoon. The devastating floods often have disastrous consequences: major damage to infrastructure, great loss of property, crops, cattle, poultry etc. With every major flood in Bangladesh, food security and poverty situation adversely affected.

**KEYWORDS:** Water Resource Management; Geo-Technology; Adaptation; Drainage; Monsoon; Mitigation Strategy; Early Warning

# *AUTOMATIC CALIBRATION OF ARID FLASH FLOOD MODELING FOR WADI THARA WESTERN KINGDOM OF SAUDI ARABIA*

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**ABSTRACT**

Input parameter calibration to flash flood models is the most critical stage of the overall flood modelling processes, where the input parameters values are adjusted to make the simulated flood hydrographs fit the corresponding records. Wadi Thara (275 km2) in the Western Kingdom of Saudi Arabia (KSA) is selected and hourly rainfall data is extracted from the paper charts. Five-minute observed runoffs are analysed and ASTER Digital Elevation Model (DEM) with 30 meter pixel size is processed to compute automatically the morphometric parameters and to extract the geometric features of the catchment. Hydrological soil group (HSG) map and land cover/land use (LCLU) map are developed to estimate the excess rainfall using composite SCS curve number (SCS-CN). Clark unit hydrograph (Clark-UH) time of concentration approach is used to transform the excess rainfall to flood hydrograph. Four parameters are chosen for calibration, which are SCS-CN, initial abstraction (*Ia*), Clark–UH time of concentration (*Tc*) and Clark storage coefficient (*R*). Nine observed runoff events are selected for modelling; seven different events are chosen for parameter calibration and two for parameter validation. This study focuses on calibrating the peak flow only, which is the most critical hydrograph characteristics in rainfall-runoff modelling in arid regions. Calibration process produced exact peak flow for five out of seven events and one event with very close match (-2.6% of change). On the average parameters calibrations for SCS-CN, *Ia*, *Tc* and *R* are 81.6, 11.0 mm, 3.81 hr., and 1.88 hr., respectively, where R is the most highly variable parameter with 139% coefficient of variation. The reason behind this variation may be because of the local search algorithms usage, which produce local minimum objective function and assign optimized value to the parameter that is not in existence, also the selected hydrological methods are lumped, where the spatial rainfall variation and the other input parameters are not taken into consideration. In the validation process, the four average calibrated parameters are used to validate two events, the first event produced a peak flow with -50% change, which can be considered as relatively high, while the second event resulted in a peak flow with -6.0% change. The value of calibrated parameters are very valuable and can be used in the future for the same and similar catchments. More optimization module applications may be needed with global search algorithm and multiple objective functions to enhance the estimated parameters in future studies.

**KEYWORDS:** Parameter estimation optimization; rainfall-runoff modelling; arid regions; Wadi Allith.

# *FLOOD FORECASTING IN ALGERIA BY TANK MODEL USING ADAPTIVE EXTENDED KALMAN FILTER*

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**ABSTRACT**

Every year the floods cause tens of deaths in Algeria and in all the countries of the world. The development of a real-time forecasting model could mitigate the damage and be part of a national and international strategy to combat the floods.

In this study a model based on Sugawara Tank (1964, 1974, 1979) adapted, was used in flood forecasting in Algeria. The efficiency of this model coupled with the Kalman filter in the reconstitution of flood hydrographs in real time at different time steps is remarkable and can thus be a means of flood control in Algeria characterized by Mediterranean and semi-arid climate.

The evaluation parameters of the prediction series compared to the recorded series (Nash, R2 RMSE, and PBIAS) are very encouraging, essentially the implementation of the Kalman algorithm in the extended form, the parameter called Kalman gain comes to confirm these tested results for the prediction and simulation of a number of historical hazards in different regions of Algeria.

**KEYWORDS:** Forecasting; Floods; Real Time; Modelling; Algeria.

# *STORM FLOW GENERATION IN UNGAUGEDWATERSHEDS BASED ON GEOMORPHOLOGICAL CHARACTERISTICS: CASE STUDY OF BILLI DRAINAGE BASIN, EGYPT*

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**ABSTRACT**

Understanding the hydrological variability and causality in different natures still challenging. Especially for arid regions, where the reliable long-term field measurements and experimental research is limited. Therefore, the researchers depending on humid zone experience, which produce unreliable results due to ignoring the specific features of dryland response. The aim of this paper to develop deep understanding of the rainfall-runoff process within ungauged arid drainage basins based on the theoretical linkage between the watershed's geomorphological characteristics and its hydrologic response. Wadi Billi locates in the Eastern Desert of Egypt, and it was exposed, on 9$^{th}$ March 2014, to a flash flood event that extended to the Red Sea coast causing damages to humans and infrastructure. A morphometric database of 82 parameters for all aspects has been developed using GIS techniques for Billi drainage basin and its sub-basins to understand the context of the landform development, its characteristics, and the pattern of its contribution to the hydrological system in the light of literature. However, for the reason of the study, only five sub-basins have been selected as they represent extreme values for different morphometric parameters. Due to the lack of historical data and the availability of non-reliable measurements, the KW-GIUH model has been applied to investigate the hydrological response of Wadi Billi and to model the flash flood event of 9th March 2014. The statistical analysis, using Pearson correlation, classified the morphometric parameters according to their hydrological contribution to the flash flood event of 9th March 2014, and showed only 18 morphometric parameters have a significant linear correlation with all the hydrological parameters; another 18 parameters have strong contribution to specific hydrological parameter; while other parameters considered as insignificant. The results lead to isolate the most effective morphometric parameters, and this could be used to optimize the mathematical equations of the models that simulate the rainfall-runoff process within arid nature to be more realistic in representing the physical processes of flash floods. This will enhance the accuracy of the results to be more reliable for practical applications.

**KEYWORDS:** Flash Flood; Wadi; Hydro-geomorphology; GIS; Egypt.

# *EVALUATION OF TRMM AND ERA5 RAINFALL SATELLITE PRODUCTS AND THEIR APPLICATION INTO THE HEC-HMS DISTRIBUTED HYDROLOGICAL MODEL: APPLICATION TO OURIKA WATERSHED (HIGHT ATLAS, MOROCCO)*

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**ABSTRACT**

Floods are the most hazardous natural disasters. They may cause huge losses and casualties every year. In the Moroccan High Atlas, particularly arid and semi-arid regions are characterized by a strong spatial and temporal variability of rainfall and runoff. Consequently floods are causing extended damages to the population and infrastructures every year. However, research on hydrological processes is limited due to the irregularity of the gauge stations network and the large number of gaps frequently observed in the rainfall and runoff data acquired from the gauge stations, which is the case of the Tensift Hydraulic Basin
Agency (ABHT).

These environmental factors, combined to the sparsely aspect of the measurement networks and frequent gaps of data, constitute real constraints for water resources management. Remote sensing precipitation data with high spatial– temporal resolution have been shown to be a potential alternative to gauged precipitation data, which is sparse or unavailable in many locations in the study area.

The purpose of this study is to compare the results of modelling using observed precipitation data acquired from the ABHT gauge stations to satellites precipitation products data from the TRMM 3B42V7 and ERA5, as well as to assess the applicability of these data for better understanding the behaviours of the watershed and to conduct the HEC-HMS hydrological modelling to identify and characterize flood events, for flood monitoring and forecasting in the Ourika catchment. The relevance of the TRMM and ERA5 products was tested by direct comparison then a correlation with observed precipitation data at different time scales (daily, monthly, and annual) between 2010 and 2017. The precipitation data TRMM and ERA5 are calibrated with the rainfall data recorded at the five stations of the Ourika basin on the HECHMS model.

The results show that satellite products provide poor estimates of daily precipitation giving an average Pearson correlation coefficient (r) of 0.60. However, the accuracy of TRMM and ERA5 precipitation is improved at monthly and annual time scales, present with average Pearson correlation coefficients (r) respectively of 0.73 and 0.89.

The precipitation of the TRMM and ERA5 were applied to the HEC-HMS model, the results indicate that the simulated flow using the two different types of precipitation data corresponds to the observed flow, especially at the monthly and annual scales.

However, for a few extreme storm events, the data produced relatively large overestimations in the precipitation time, which caused overestimations in the stream flow simulations and deviation in the peak time, and should be regarded with caution. Generally, TRMM and ERA5 data can be an alternative source of precipitation data at monthly and annual scales, for water resources monitoring and forecasting in arid and semi-arid mountainous watershed in Tensift Region.

**KEYWORDS:** *Hydrological modelling; Stream flow simulation; Calibration; Floods events; Satellite precipitation products; Rain gauge; Arid and semi-arid regions; Ourika basin; Morocco.*

# *APPLICATION OF DEPRESSION REMOVING MODEL IN DIFFERENT TERRAIN*

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**ABSTRACT**

The Digital Elevation Model (DEM) is a representation of terrain surface which represented by different forms such as; a contour-based flow net, Cartesian grid, or triangulated irregular network (TIN). a DEM is used for delineation of catchments and determination of its morphological parameters**.** Most DEMs have topographic depressions, which are defined as areas have no outlets and often referred to as sinks.
The effect of depression varies due to topography and using of depression extracted DEM depending also on topography and this according to number of depressions, location and volume of depression.

A GIS module is used to provide depression extracted DEM. And a delineation is made on two different DEM with different terrain. Depression extracted DEM and Depression-less (Filled DEM). And it is found the topography has the significant effect on reduction due to extracted depression and its effect on delineated catchment.

**KEYWORDS:** DEM; GIS; Terrain and Depression

# *INFILTRATION AND RECHARGE PROCESSES INSIDE A WADI CHANNEL*

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**ABSTRACT**

The infiltration in wadi streams can be lower than in the surrounding sandy-gravely soils as a result of fine sediments being precipitated within the stream bed during flood events. The percentage of the infiltration as well the net recharge usually are roughly estimated according to the soil grain size distribution. In order to obtain a better estimate of the infiltration and recharge rate within a wadi stream, discharge experiments are performed on a stretch of 100 meters length of the wadi which passes through the University campus. Several flow experiments are performed by using clear water and water mixed with silt collected from a nearby dam to simulate the natural flow mixture. Soil moisture, temperature and electrical conductivity are continuously recorded by using 10 soil sensors. The run-off is measured by V-notch weirs at the inlet and outlet of the channel stretch. The measurements of the experiments are used to calibrate a numerical model. The experiments and the evaluations are very useful in order to provide better estimates for net groundwater recharge in wadi channels.

**KEYWORDS:** Soil Sensors; Aquifer Recharge; Arid Climate

# *ASSESSMENT OF FLASH FLOODS IN SIJOUMI WATERSHED, TUNIS*

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**ABSTRACT**

Flash floods are among the natural and anthropogenic phenomena that cause human and heavy material damage. Recently, different cities in Tunisia have been affected by several extreme rainfall events. The present study first examines extreme rainfall events in the Manouba Sijoumi Watershed using various statistical analysis methods. Rainfall data of three stations (Tunis Manoubia, Mnihla, Tunis Carthage) registered over the period (1985 – 2018) were analyzed. The main objective is to highlight the interrelationship between climate change and the risk of flooding, especially the frequency of extreme rainfall events and their associated intensities.

Nine rainfall indices were computed: total rainfall (PTOT), total number of wet days (with daily rainfall ≥ 1 mm, JP), maximum rainfall recorded in 1 day (Px1J), mean wetness per day (wet day) index, SDII), the total number of days characterized by rainfall ≥ 10 mm, 20 mm and the 95th, 99th and 99.5th percentiles. Since 1993, an increase in the number of extreme rainfall events has been observed. A maximum was recorded during the year 2003/2004, with 5 events for each of 3 studied stations. In 2003, the maximum rainfall reached 975 mm. The increase in the frequency of exceptional events may be explained by climate change effects.

The second part of the study deals with the delineation of flooded areas in the study watershed using the Analytical Hierarchy Process (AHP) method. The method takes into account different factors, such as rainfall spatial distribution, topography, soil type, land use and urbanization. Post event field observations shall be collected to validate the obtained flooding map.

**KEYWORDS:** Climate change; rainfall index; flood mapping; Analytical Hierarchy Process

# *CLIMATE CHANGE AND THE PROTECTION OF EGYPTIAN BEACHES*

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**ABSTRACT**

The world is witnessing the phenomenon of climate change, which has become a reality due to the continuous rise in temperature and the resulting melting of ice in the Arctic and rising sea level, which threatens the beaches and coastal cities. Egypt is interested in this phenomenon because it is one of the most affected countries. As Agriculture accounts for 20% of the national income and employs more than 50%.And Egyptian beaches, which reaches a length of 3500 km on the coast of the Mediterranean Sea and Red. The possibility of submerging some areas in the lowlands of the delta coast, salinizing the delta lands, threatening the coastal cities and their beaches, and modifying the levels of the drainage stations on the sea. Hence, adaptation to the phenomenon of climate change was the strategy of the State to protect the Egyptian coast.

At the local level, many adaptation projects to climate change, such as protection facilities along the northern coast, have been implemented. In addition to re-evaluating the development plans of the regions of Alexandria, Port Said and Damietta especially port areas as well as tourist villages and reconstruction areas in general along the shore, raise the level of the lakes embankments of Edco, Mariout and Borlos to be higher than the level of water in the lakes and conservation and attention to the sand dunes in the central Delta and prevent their removal or aggression on her.

**KEYWORDS:** Climate Change; Egyptian Beaches; Sea-Level Rising

# *IMPACTS OF FLASH FLOODS ON URBAN PLANNING: CASE OF WADI ELGIEA IN OMDURMAN-SUDAN*

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**ABSTRACT**

Annually world-wide flash floods in rivers, wadis and seasonal streams are causing huge damages to properties, infrastructures and even loss of human lives. In Sudan, many urban areas are situated in zones that are vulnerable to flash floods. In Greater Khartoum, the capital of Sudan, the urban areas are penetrated by many seasonal Khors such as Wadi Elgiea, Khor Shambat and Abo Anga, in Omdurman; and Wadi Suba in Khartoum North. This paper is aimed to assess the impacts of Wadi Elgiea flash floods on urban areas situated on the downstream of its catchment. Also to investigate the effectiveness of the proposed dams in reducing the peak flows of the Wadi. Survey works, hydrological and hydraulic studies were conducted to evaluate the situation. The study suggested several mitigation measures and produced guidelines for planning and sustainable management that can be replicated in many urban zones with similar conditions to Wadi Elgiea in Omdurman City.

**KEYWORDS**: Flash floods; urban planning; Wadi Elgiea

# *OMAN WATER SOCIETY EFFORTS IN FLASH FLOODS MITIGATION*

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**ABSTRACT**

Oman is an arid country where temperatures are very high during and receive very little rainfall (annual average 51 mm) as computed by MRMWR Water balance 2013. However, the country receives thunderstorms and cyclones which results in high intense rainfall and causes flash floods. The floods occur with little warning, causing property damage, community disruption, and at time loss of lives. The main cause of floods is not limited to geology or weather, but also the distribution of human populations near water. The historical floods in Muscat shows that the areas have been flooded several times. Furthermore as a result of climate change during the recent years Oman experienced major cyclones.

Oman Water Society (OWS) is a non-profitable non-governmental organization (NGO) found by professionals working in both the Government and Private Sectors who are involved in the water management, water supply, and water projects. Recognizing the importance and necessity of unifying the efforts of experts and water stakeholders to exchange knowledge and experience in the field of tropical cyclones and flash floods, as well as reducing negative impacts of natural disasters, in addition to the early development of natural disaster risk management systems and the development of early warning systems that would contribute to forecasting and preparedness, the OWS organised four symposiums in 2011, 2012 and 2013 and lately in 2018. These efforts aimed to highlight the actions and preparations made by the concerned authorities to confront such natural phenomena in the future.

**KEYWORDS:** Cyclones; Public Awareness; Public participation.

# *QUANTIFYING MEKUNO IMPACTS AT JARZIZ WATERSHED IN DHOFAR*

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**ABSTRACT**

The southern parts of Oman have witnessed various cyclonic events including ARB01 (2002), Keila (2015), Mekuno (2018) and Luban (2018). The purpose of this study is to assess the flooding damage at Jarziz watershed due to flash wadi (dry river) flooding. This study used a 3Di hydrodynamic model to quantify and map the flood damage and extent due to Mekuno and to identify vulnerable industrial, residential and commercial areas at various water depth ranging from 0.50 m to 5.0 m within Jarziz watershed. The results showed that at 0.5 m water depth the damage was 33 M, 73 M, and 203 M for industrial, residential and commercial areas respectively. While at 1.0 m water depth the damage was 8.6 M, 41 M, and 74 M for industrial, residential and commercial areas respectively. This study contributes in providing knowledge to make informed policy decision toward resilient infrastructure, and to provide risk assessment in efforts to prepare Oman for any future natural disasters.

**KEYWORDS:** Flash wadi flooding; 3Di; Oman; Damage Assessment

# *IMPACTS OF FLOODS ON THE TRADITIONAL WATER SYSTEM IN SULTANATE OF OMAN*

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**ABSTRACT**

In the last five years many gulf countries such as the sultanate of Oman, Saudi Arabia, United Arab Emirates and Yemen have experienced tropical cyclones and floods. Most of these cyclones have been generated in the Arabian Sea which is the part of the Indian Ocean, north of the equator and west of India. These cyclones have caused flash flooding that has impacted on the traditional Omani water system called falajs and also affected springs. This paper is going to discuss the most important water resources in the sultanate of Oman and how the society try to preserve these resources with helping of government. Specifically, the paper will discuss the impacts of floods on the falajs and springs that are located in different places in the Sultanate of Oman. It will show the emergency plan that is put by government to deal with the impacts of flash floods. The impacts will be presented in this paper using GIS photos and charts. Additionally, this paper is going to discuss the monitoring system of rainfall that are used near falajs and springs. The findings of this paper will show that the government did a lot to save the water resources and still put a special priority to protect these resources from disasters. In brief, this paper discusses the impacts of floods on the water resources which struck the Sultanate of Oman in the last years in order to reduce the impacts of natural disasters in the future.

**KEYWORDS:** Falajs, Springs; Omani Society; Floods.

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