Modeling and Simulation of Large Dams
Badush Dam as a Case Study

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Badush Dam – Case Study

Badush Dam Site

located on the Tigris River.

22 km d/s of Mosul Dam and 23 Km NW
of Mosul city.

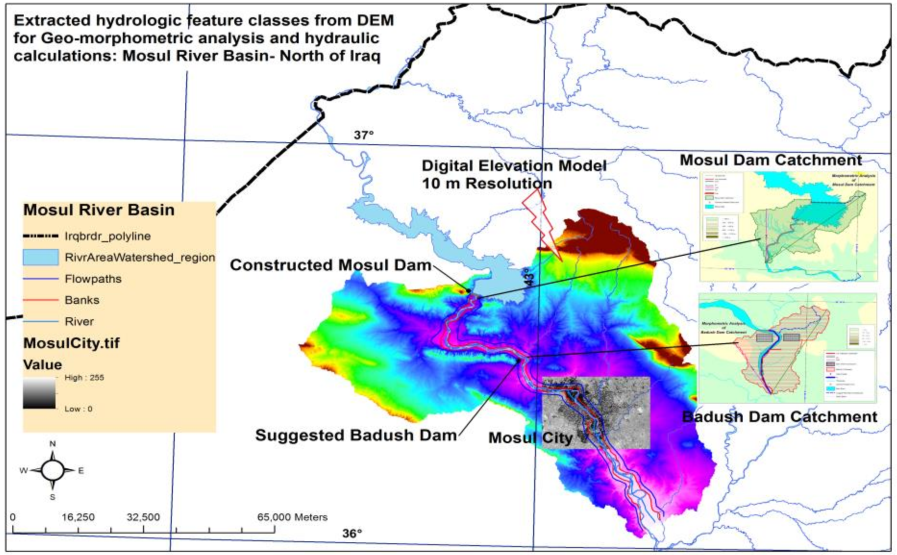
Dam construction was started in 1989 and stopped
a few years later at the app. 35 % level

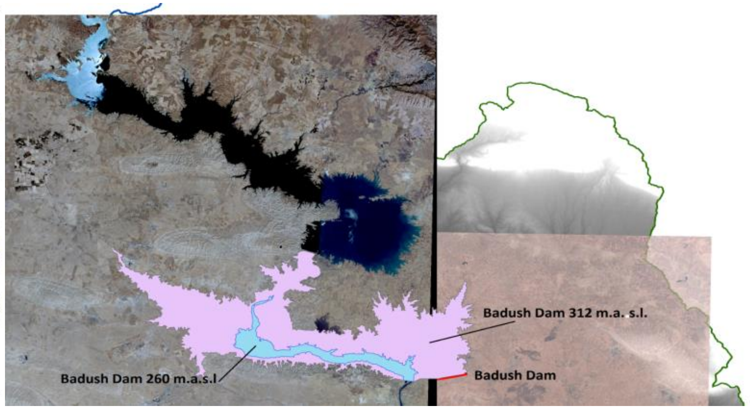
It is an earth fill / concrete dam 3686m long, with
Crest elevation:

1st stage 260 m.a.s.l,
and for 2nd stage (final stage) 312 m.a.s.l.

- Height: for first stage is 35m,
and for the final stage is 92m.
- Normal storage: at elevation 245 m.a.s.l = 350*10^6 m3.
- Maximum storage: for the 1st stage 400*10^6 m3
for the 2nd stage 1.14*10^10m3

- The main purpose for the dam construction
(in the 1st stage) is power generation,
with possibility of rising the crest of the dam
from 260 m.a.s.l up to 312 m.a.s.l
for repulse Mosul dam water wave in case of failure.

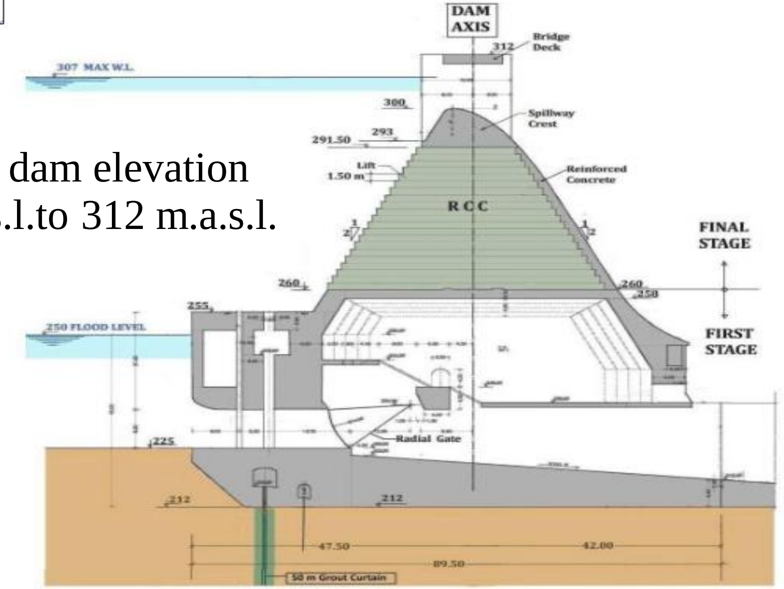




Estimated reservoir volume 1.4 x 10^10 m^3

Current Situation of Badush Dam

Modified dam elevation
260 m.a.s.l.to 312 m.a.s.l.

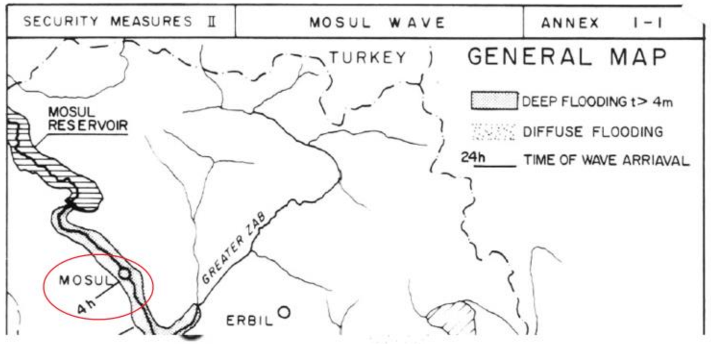


Risk Analysis

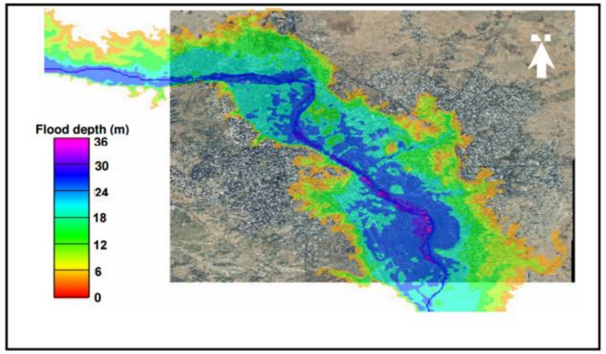
- According to the Dam Break Analysis studies, Mosul City need to be protected from the predicted collapse of Mosul Dam.
- In case of Mosul dam failure, people should evacuate the city within approx 2 hours.
- Expected level of flood alongside both banks is 3-24 m.
- People should be excluded for about 5 km from both sided of the Tigris river (Dijle).
- Thus, Badush Dam has been proposed as a best solution for retaining upstream reservoir.

Related Studies – Mosul Dam

- SWISS Consultants, 1984
- International Water technology Conference, Mosul University, 2009
- Joint Research Centre European Commission, 2016
- Center of Flow Simulation, Düsseldorf University, 2018



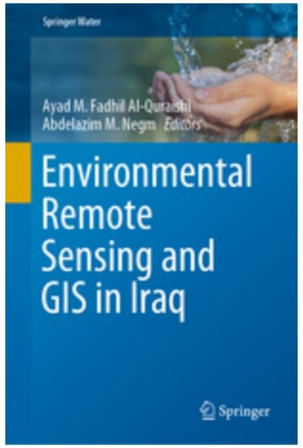
SWISS Consultants, 1983

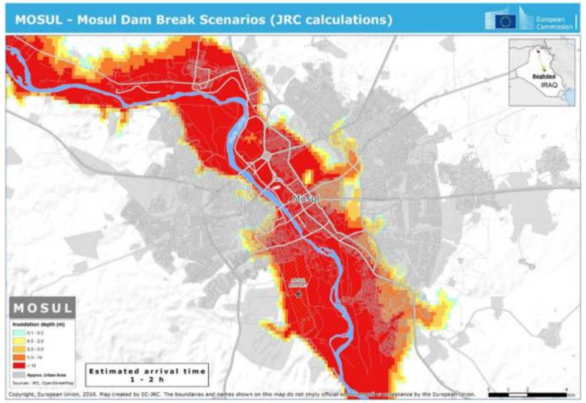


IWTC, 2009

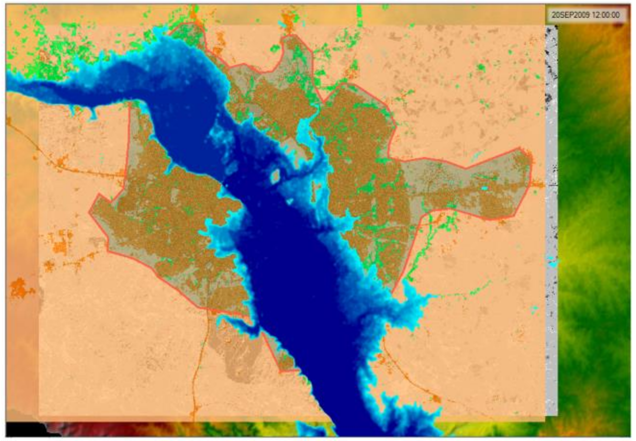
Environmental Remote Sensing and GIS in Iraq, Springer, 2019

Chapter 16: Saeedrashed, Y. and Benim, A. C., Geo-morphometric analysis and flood simulation of the Tigris River due to a predicted failure of the Mosul Dam





JRC, 2016

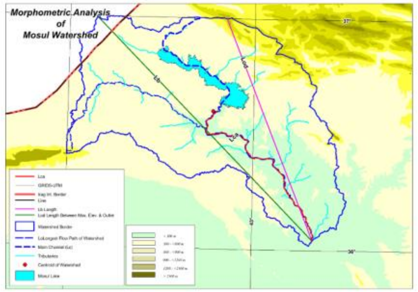


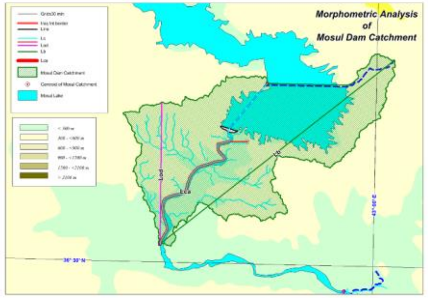
CFS, 2018

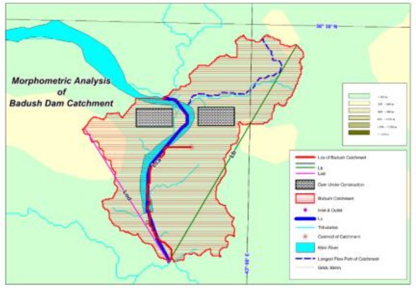
Hydrologic and Hydraulic Modeling

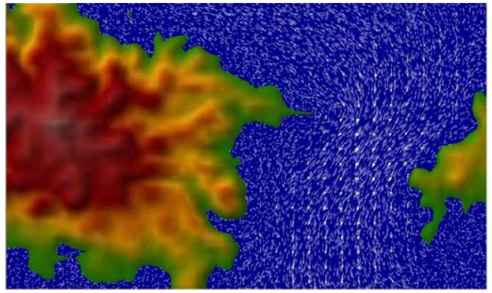
Comparison between the recent study and the previous studies

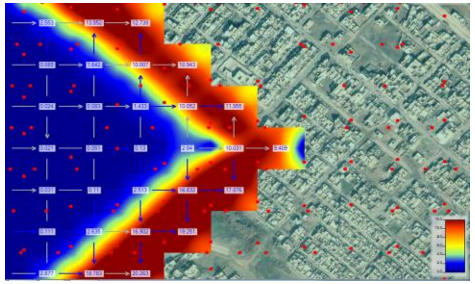
Hydraulic Parameters	***Studies***			
	SWISS, 1984	IWTC, 2009	JRC, 2016	CFS, 2017
Maximum flood discharge ($10^3 m^3$)	402.000	-	-	404.875
Speed of flood at the beginning of dam failure (km/hr)	40	-	40	38
Time of wave arrival to the Mosul city (hr)	1.5	1.7	1.4	1.9
Time to maximum wave height in Mosul city (hr)	8.5	9	6.2	8
Average flood velocity in Mosul city (m/s)	4.4	3.5	-	3.9
Max. flood level in Mosul city (WSE) (masl)	242.7	235.2	236.2	232.3
Maximum flood depth in Mosul city (m)	-	36	-	36.7
Maximum flood depth in Tigris River (m)	46.3	-	-	42.64
Maximum wave height in Mosul city (m)	24.3	25.2	26.3	24.01
Inundated area within the city (km^2)	74	-	-	121.6
% Inundated area within the city	-	54	-	58
Flood width around river bed (km)	3-10	-	-	4.5-11
Advisable evacuation distance (km)	-	-	4-5	5
Shear Stress in river bed (N/m^2)	-	-	-	1.5-42.6
Stream power of river (kW)	-	-	-	1.49-54.9
Stream power of flood (MW)	-	-	-	3.3-12.39

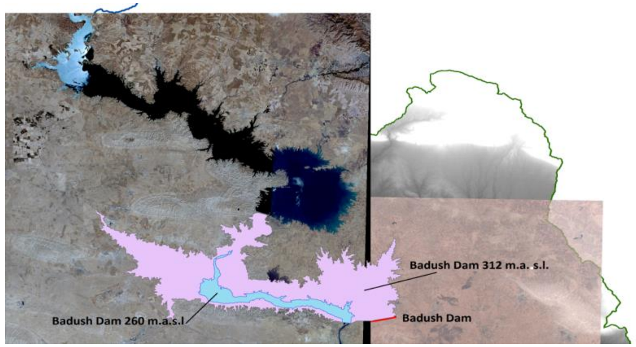








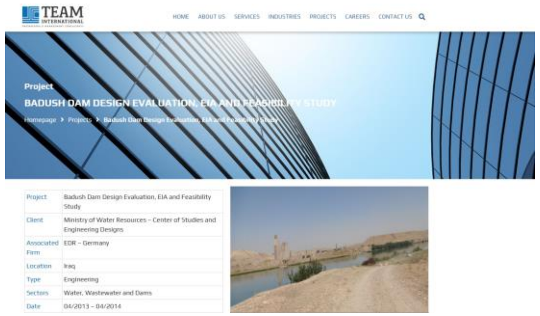


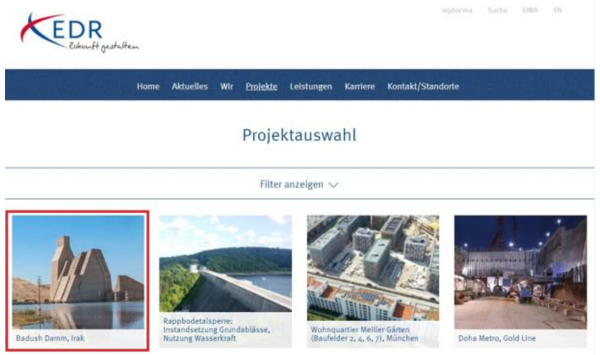


Dam	Water level (masl)	Dam Height (m)	Reservoir Volume (m^3)	Reservoir Surface Area (m^2)
Badush (existing)	260	35	0.39×10^9	40.1×10^6
Badush (proposed)	312	92	9.8×10^9	357.69×10^6

Involved Stakeholders & Implemented Studies

- Ministry of Water Resources (Iraq)
- Team International (Lebanon)
- EDR (Germany)
- USACE (USA)
- United Nations – FAO
- Other Related International Companies





- 1988 Energoprojekt
- 2008- 2009 EL CONCORDE, Jordan, MED INGEGNERIA, Italy, PAUL C. RIZZO, USA and ENERGOPROJEKT
- 2013 – 2014 Team International & EDR

1. Design evaluation in regards to power generation and raising the crest elevation from 260 m.a.s.l to 312 m.a.s.l for repulse Mosul dam water wave in case of dam break.
2. Environmental Impact Study covering biodiversity, soil, surface water and groundwater, climate, geological conditions, geomorphology, seismic hazard, sediments, plant production, animal production, agriculture, inhabitation, archaeological and cultural heritage, and solid, liquid and gas wastes.
3. Feasibility study of hydro-power generation compared to other alternatives, taking into consideration other benefits, like agriculture, water storage

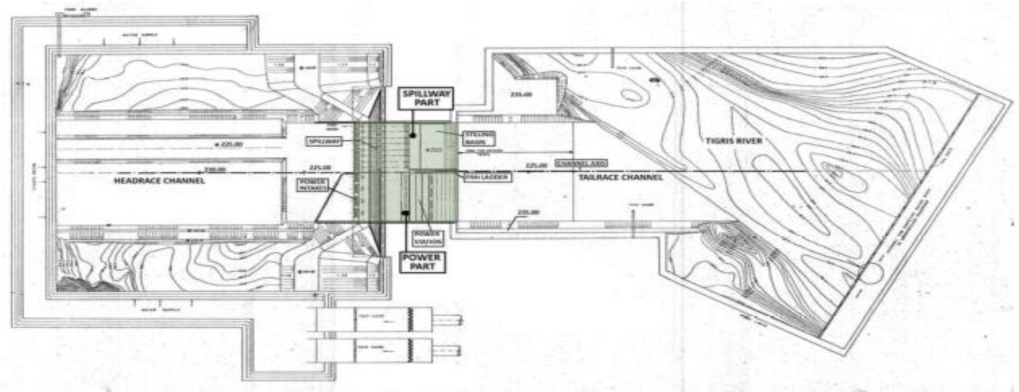
Physical Modeling and Computational Modeling/ Simulation

- Establishing new related physical model for achieving **optimization/ cost effective project.**

- Using three advanced applications (CFD, Programming Languages and HPC) for performing related **optimization processes to the large dams** (design and performance improvement).

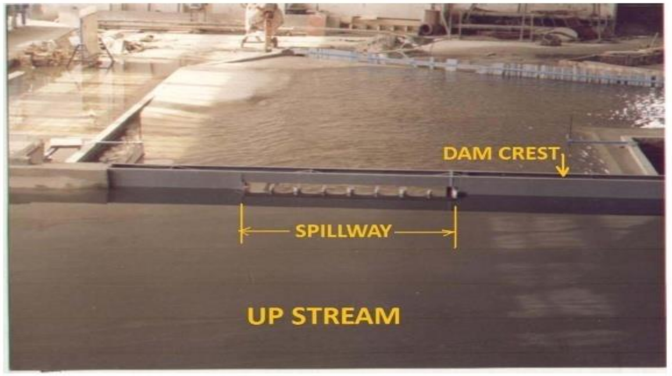
Physical Modeling

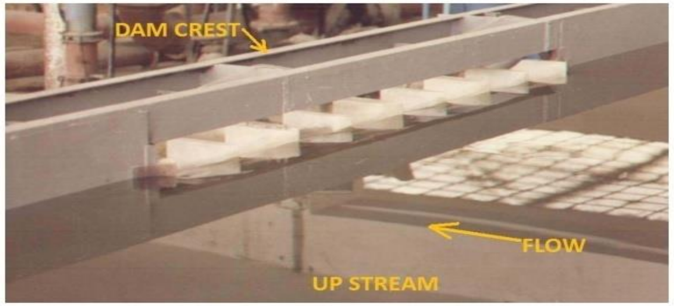
1988, JAROSLAV BERNI, Belgrade, Institute for development of water resources.



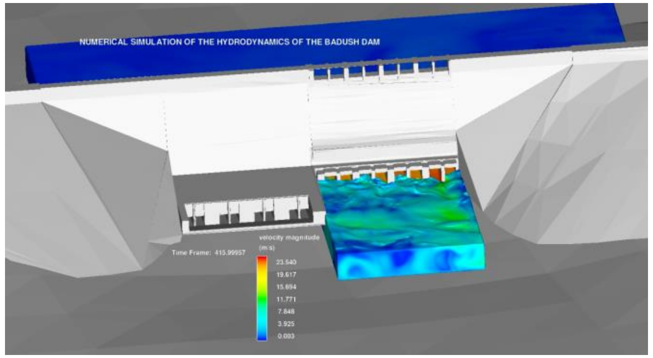
Scale 1: 60

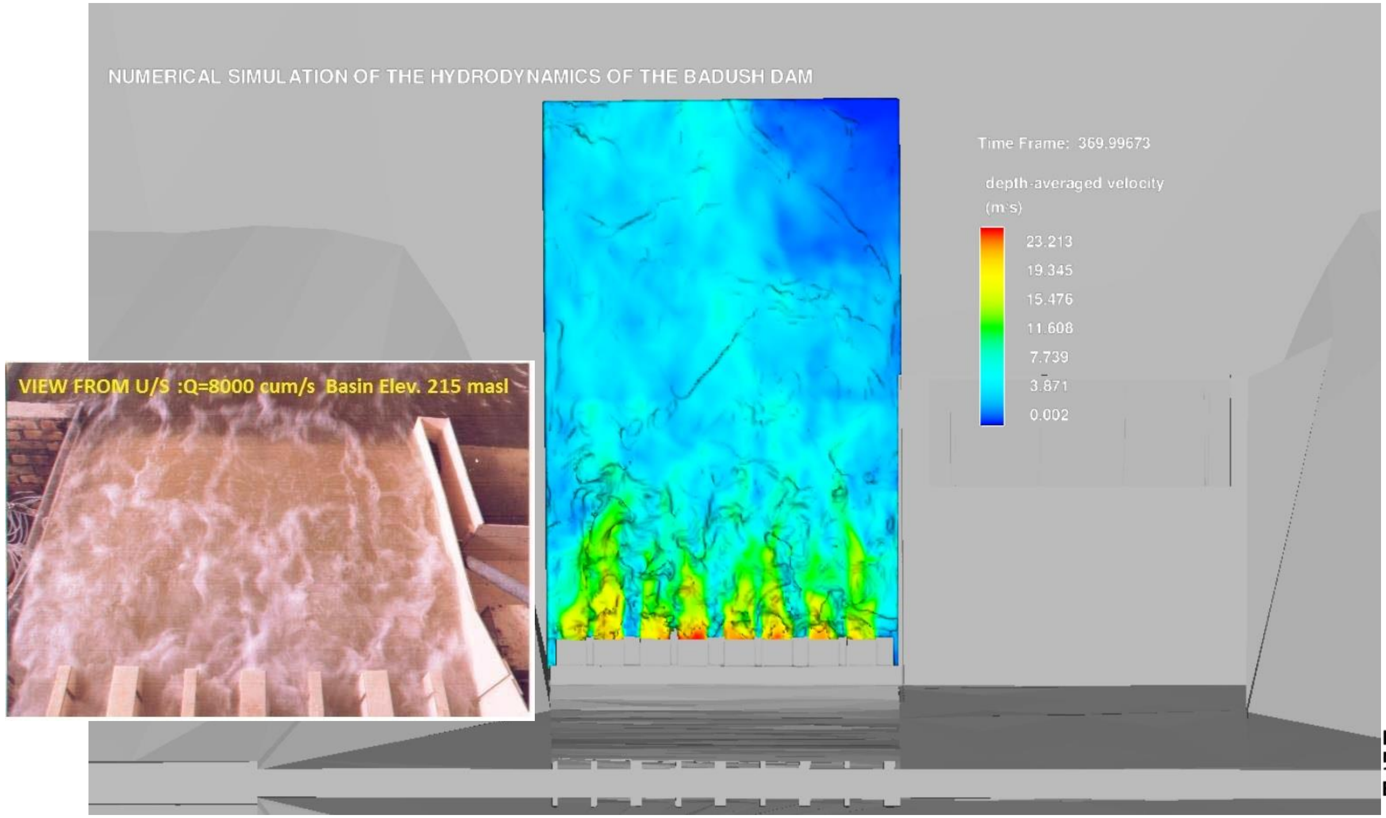
Downstream View Of The Model showing the Flip Bucket Operation

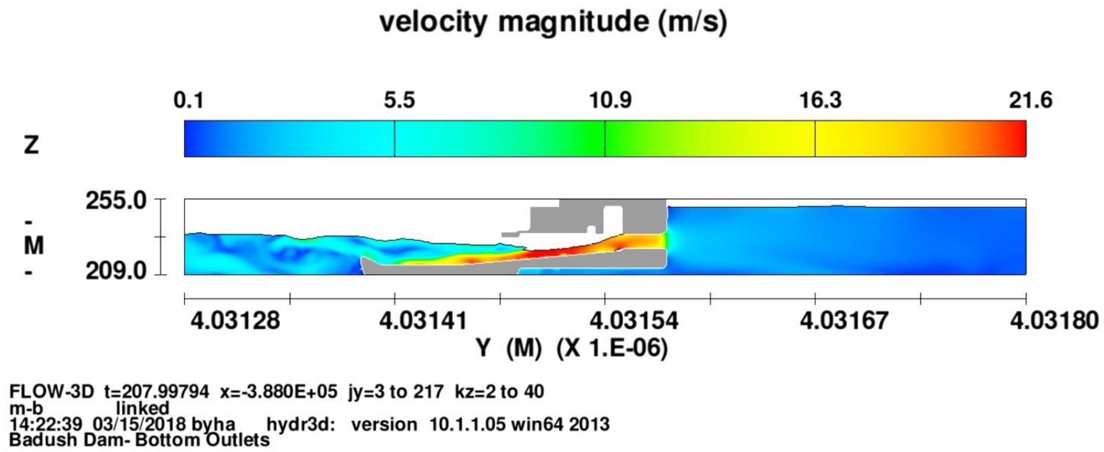


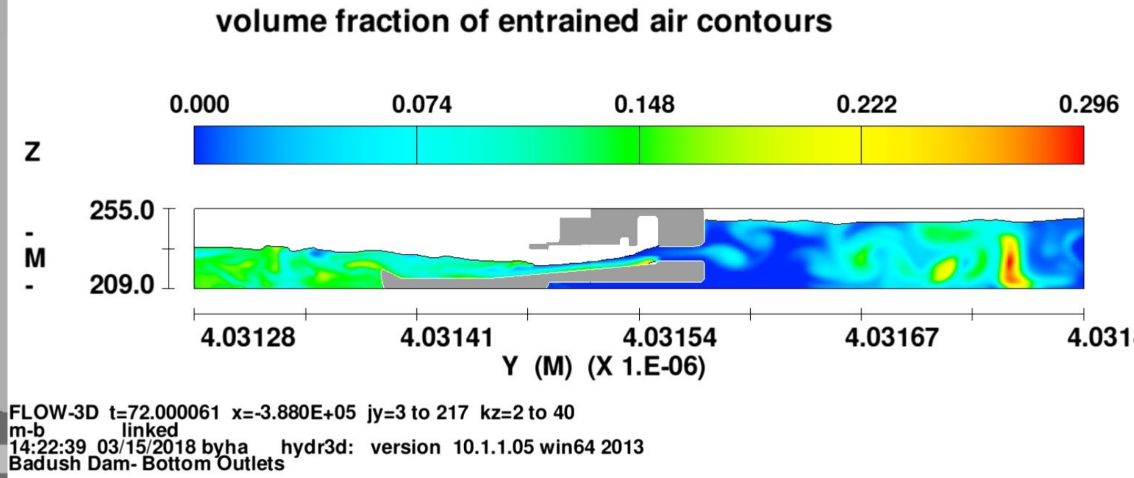


Computational Modeling & Simulation

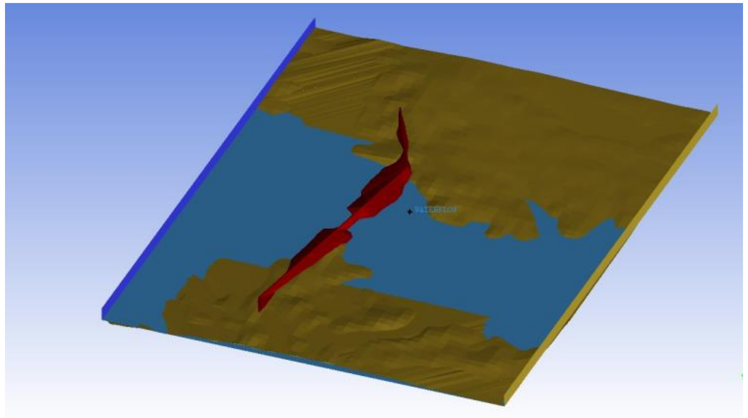








Future work: Optimization of Flood Control Systems in Large Dams



- Grid generation with much more level of detail.
- Grid Independence Study.
- Testing different types of turbulence model.
- Simulation and calibration of the model based on different scenarios and modifications in design.
- Computational-based Physical Model

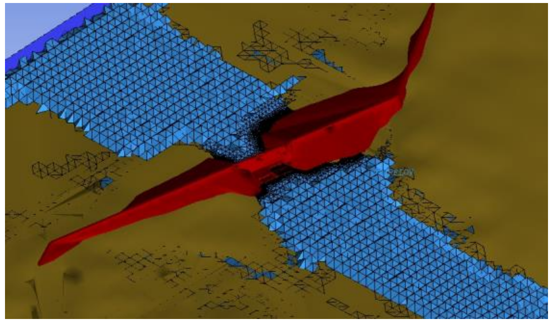
◆ Optimization of Spillway, Bottom Outlets, Stilling Basin, etc.

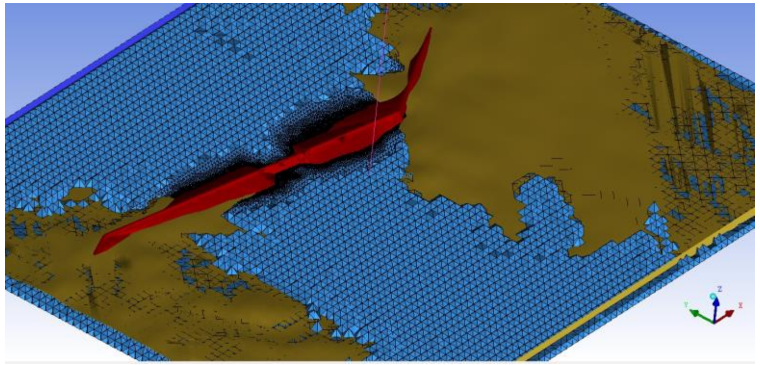
which means;

➢ Save of time

➢ More feasible water industry projects

➢ More efficient hydraulic structures





Recommendations and Services

- Establishment of center of flow simulation CFS research center for water resources industry in Iraq.

- Improvement of skills for the related technical staff, researchers and academic´s staff that enabling them to work with advanced technologies such as CFD Software, Programming Languages, and Clusters.

- CFD platform and network-based experts that support and enhance the water resources industry in Iraq.

- Exchanging experiences with the related public and private sectors.

If any Question ?

Thank you for your attendance