Sultan Alam Memorial Prize Lecture: Innovation in Sedimentation Management

"More and more hydro and water projects around the world are facing sediment-related problems. These include hydroelectric projects with high dams or run-of-river schemes in the Himalayas, low head run-of-river schemes with large sediment loads in the Amazon, large scale sediment diversion in the Lower Mississippi river in the USA to prevent wetland degradation and sedimentation of navigation dams and channels in the delta area, and multipurpose storage dams for irrigation and water supply throughout the world". - *Sultan Alam, "Aspects of sediment management in various parts of the world"; Proceedings, ASIA 2012 - Water Resources and Renewable Energy Development in Asia.*

In memory of the global sedimentation expert, Sultan Alam (1928~2017), we are inviting candidates to submit papers to be considered for presentation at HYDRO 2020, recognizing improved knowledge in the field of sedimentation and to further advance appropriate planning and implementation of sedimentation management. Three papers will be selected for presentation and prizes, as detailed below.

Submissions are now invited

Criteria for submission of papers

- Papers will be considered which cover one aspect from the full spectrum of sedimentation issues, including, but not limited to: innovative technology, a new research programme,project planning, including a proposed sediment removal system, by-pass channels, numerical and physical modelling, monitoring, hydraulic design, or sediment transport. In the case of theoretical research, the introduction should clearly explain future application of the research in practice.
- The paper should not exceed 5000 words in length. It should be the author's original work, and should not have been published previously
- Entry is open to current or recent graduates (within 3 years of graduation), under the age of 40 years.
- Entries should be submitted to steve.usher@hydropower-dams.com before 30 August, 2020. Candidates should be prepared to present the papers at HYDRO 2020 in Strasbourg, if invited to do so.

Award selection

Awards will be presented to the lead authors of three selected papers. The winning papers will be selected for presentation at HYDRO 2020, and for the prizes listed below, by a panel of international experts with a combined experience of more than 100 years in the field of sedimentation. Additional papers submitted may be considered for publication in *Hydropower & Dams.*

Prizes

First Prize: Complimentary registration to attend HYDRO 2020, economy class return travel to the event, hotel accommodation during the event, and a cash prize of US$500. Publication of the paper in the *International Journal on Hydropower & Dams.*

Second Prize: Complimentary registration to attend HYDRO 2020, hotel accommodation during the event, and a cash prize of US$250.

Third Prize: Complimentary registration to attend HYDRO 2020, hotel accommodation during the event.

Please notify us of your intention to enter by 3 July, stating your full name, place of study, contact details, and the proposed title of your paper, via email to: steve.usher@hydropower-dams.com

Reservoirs cannot complain themselves to be overfed with sediments…..

…but fortunately the reservoirs were defended during decades by the silent voice of an extraordinary personality

Sultan Alam

1928 - 2017

Contents of presentation

1. Importance and reasons of reservoir sedimentation
2. Measure against reservoir sedimentation
3. The critical voice of Sultan Alam
   - Site selection and project layout
   - Innovative arrangement by using forebays as settlement basin
   - Assessment of sediment load and characteristics of sediment material
   - Small-scale physical models and/or numerical models to validate concepts
4. Conclusions – **Sultan Alam Award** for young engineers

LABORATOIRE DE CONSTRUCTIONS HYDRAULIQUES

Prof Anton Schleiss

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Importance and reasons of reservoir sedimentation

Sedimentation

=

Filling up of lakes by sediments

All lakes and reservoirs are submitted to this process

Reduction of the useful storage volume of reservoirs

Problem of sustainability

Mauvoisin arch dam in Canton Wallis

Sediments in front of the bottom outlet during emptying in May 1985

Importance and reasons of reservoir sedimentation

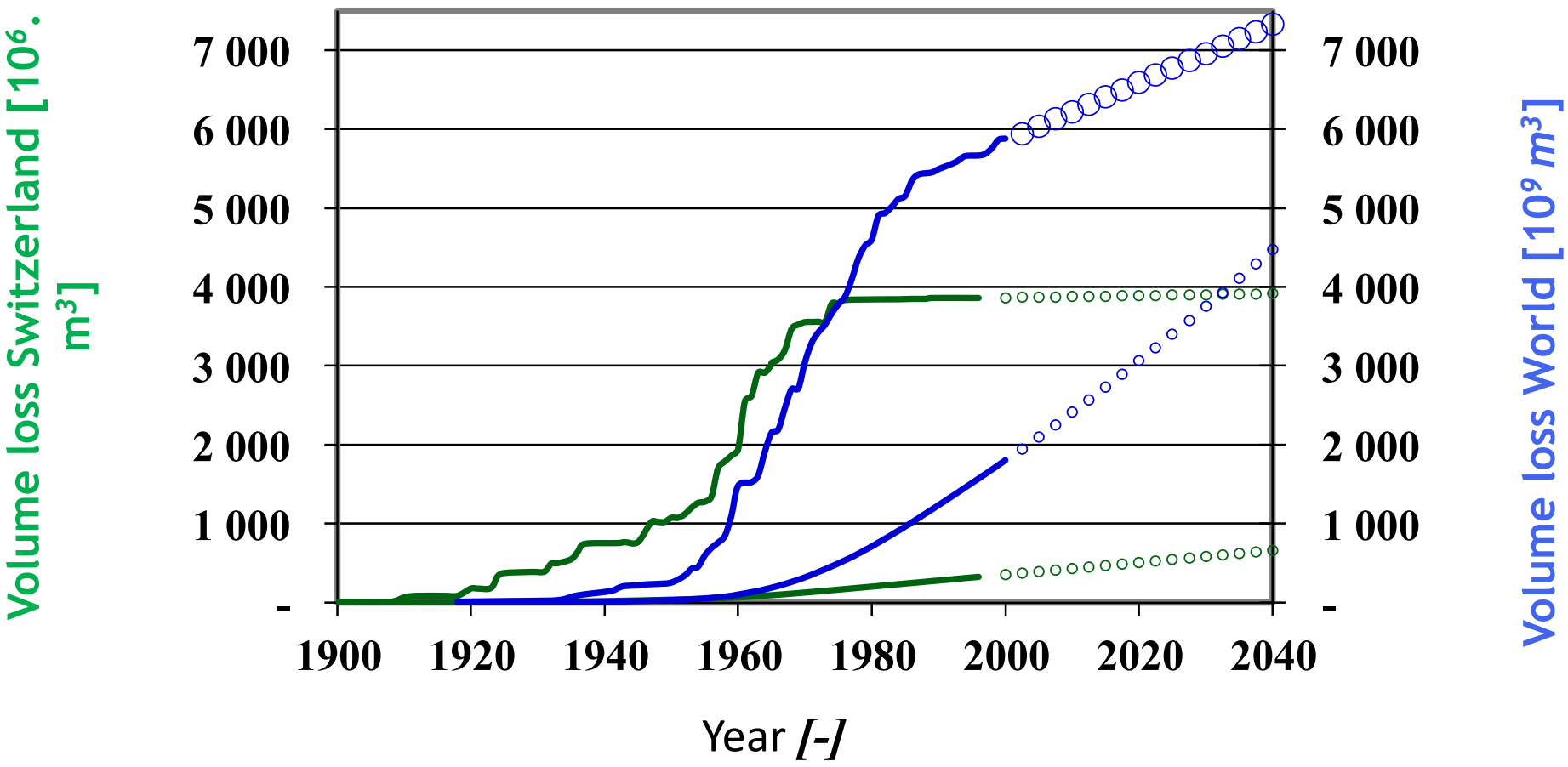
Products of surface erosion in catchment areas

Bed load → Deposition in delta

Suspended material → Deposition distributed over reservoir → Transport by turbidity currents during floods

Mauvoisin reservoir during emptying in May 1985

Problem of reservoir sedimentation



Comparison of increase due to construction and loss due to reservoir sedimentation

Problem of reservoir sedimentation

Year current storage will reach critical sedimentation levels

Region	Hydropower Dams: Date 80 % filled with sediment	Non-hydropower dams: Date 70% filled with sediment
Africa	2100	2090
Asia	2035	2025
Australasia	2070	2080
Central America	2060	2040
Europe and Russia	2080	2060
Middle East	2060	2030
North America	2060	2070
South America	2080	2060

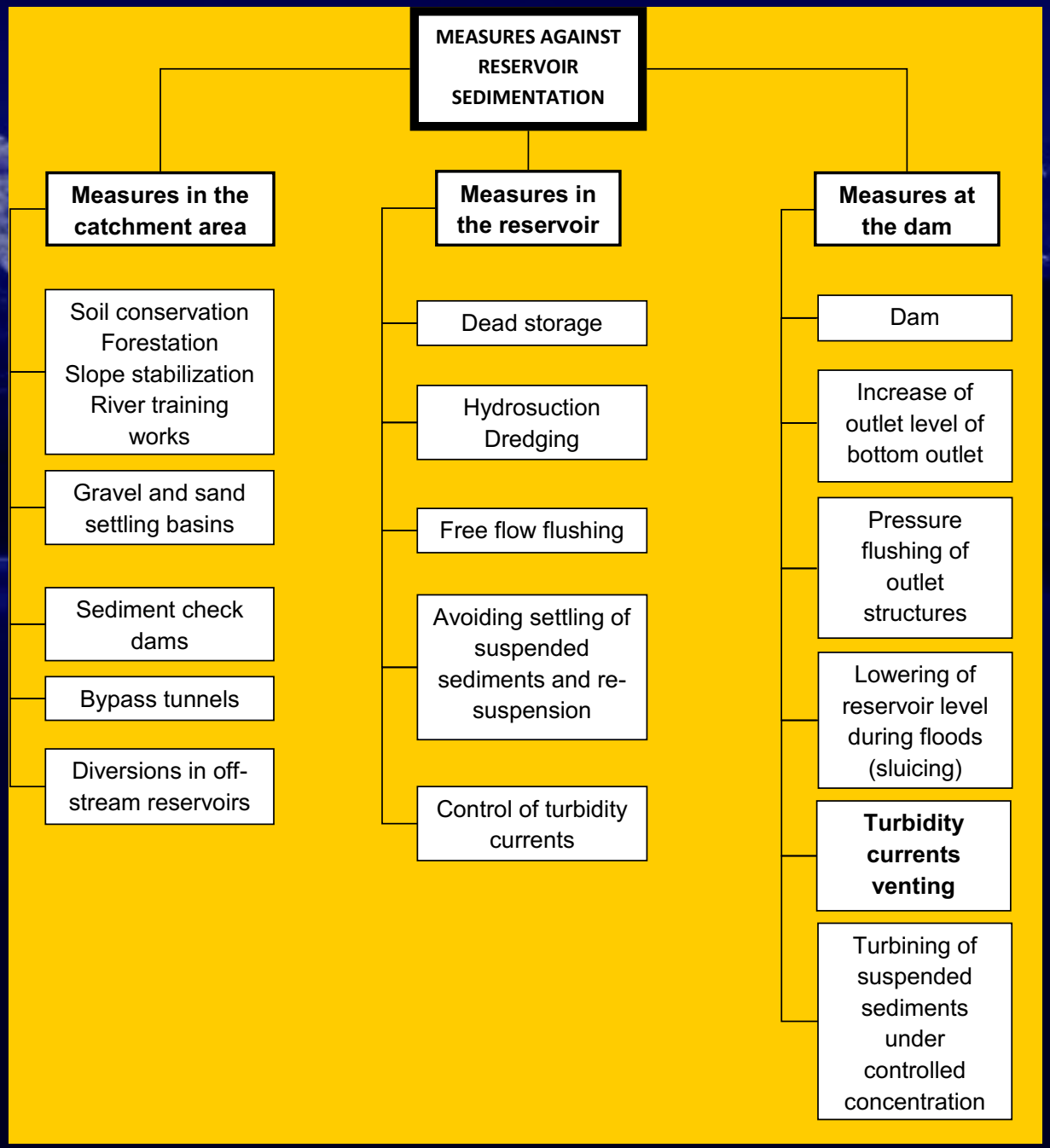
Basson, General Report ICOLD 2009

Measures against reservoir sedimentation

- When ?
  - preventive
  - retroactive
- Where ?
  - in catchment area
  - in reservoir
  - at the dam

Sufers Reservoir, Switzerland

Measures against reservoir sedimentation



Reservoir sedimentation and climate change challenges

- Sustainable use of reservoirs is more and more endangered by reservoir sedimentation since sediment yield into reservoirs will increase due to climate change

- Urgent mitigation measures are required already today at many existing reservoirs
- New reservoirs have to be designed in view of resilience against reservoir sedimentation

The critical voice of Sultan Alam Site selection

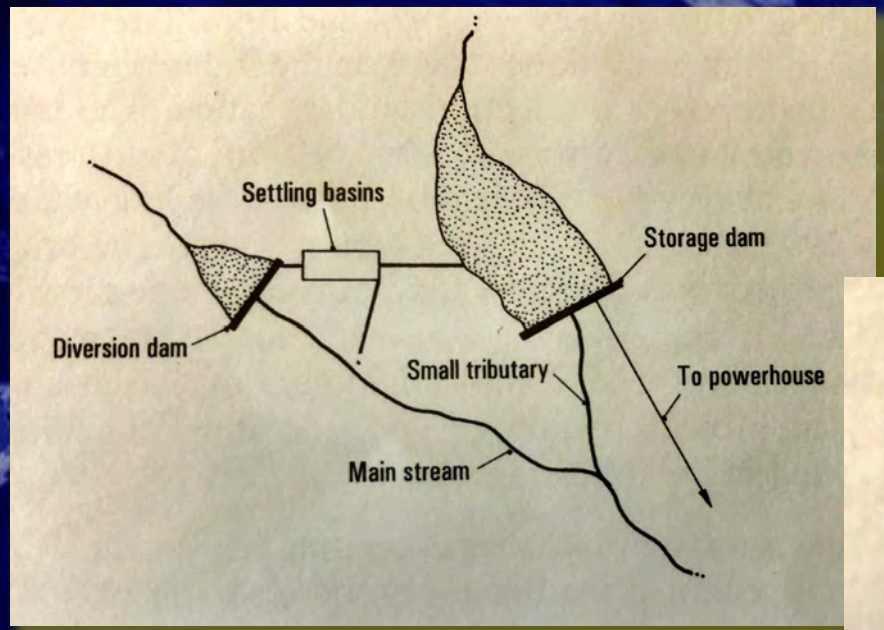
"It is important to consider alternative project arrangement to delay the sedimentation process, reduce the risk of damage and improve economic feasibility and sustainability"

H&D, Issue one, 2002 pp. 63-68

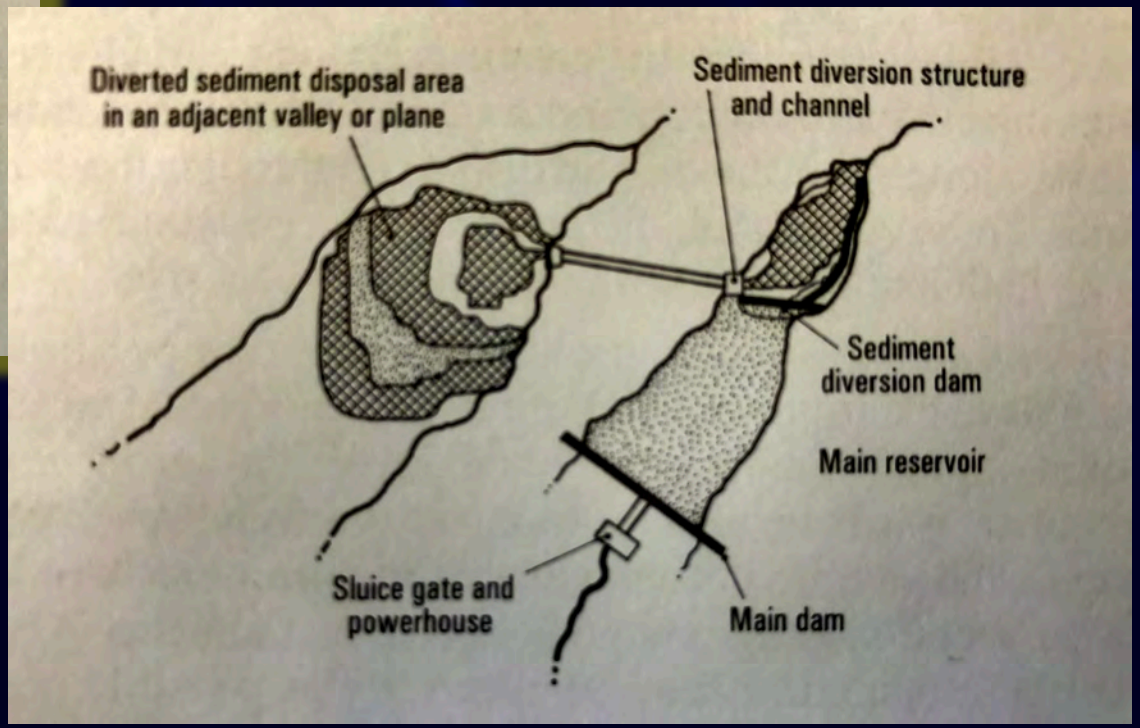
The critical voice of Sultan Alam

Site selection

Use of diversion dams



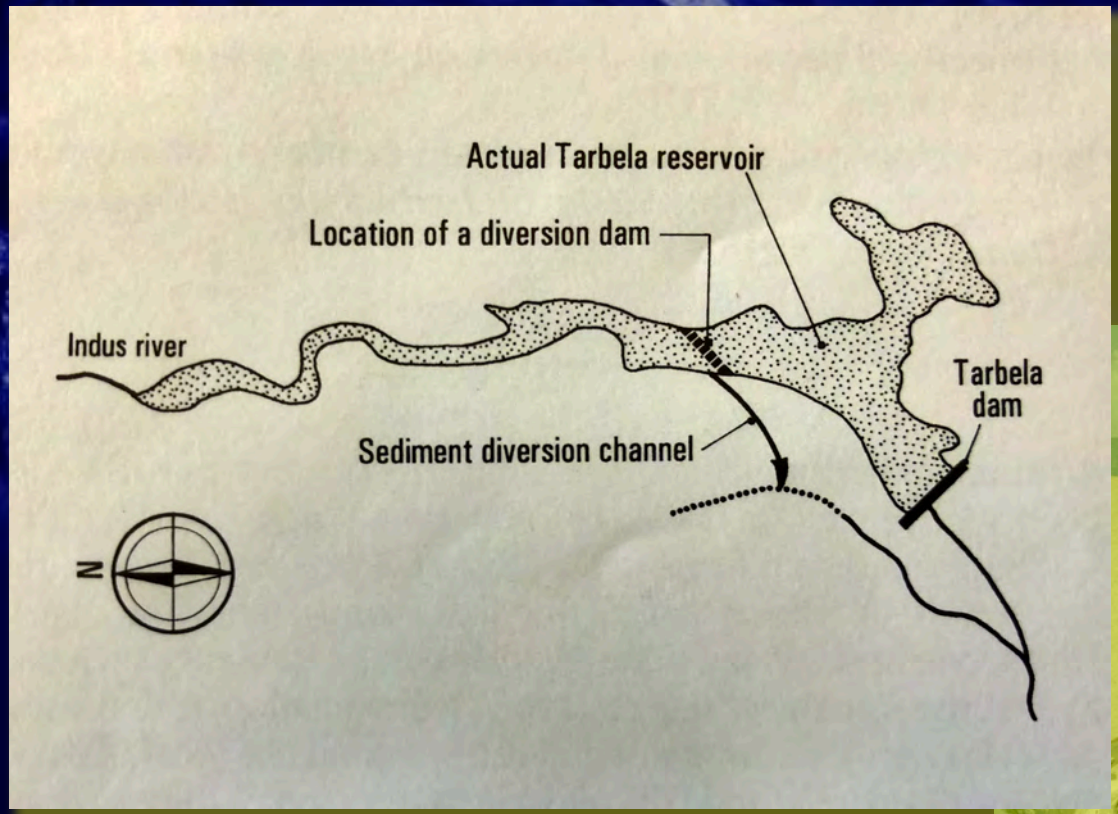
Sketch of a sediment diversion arrangement at the head of the reservoir

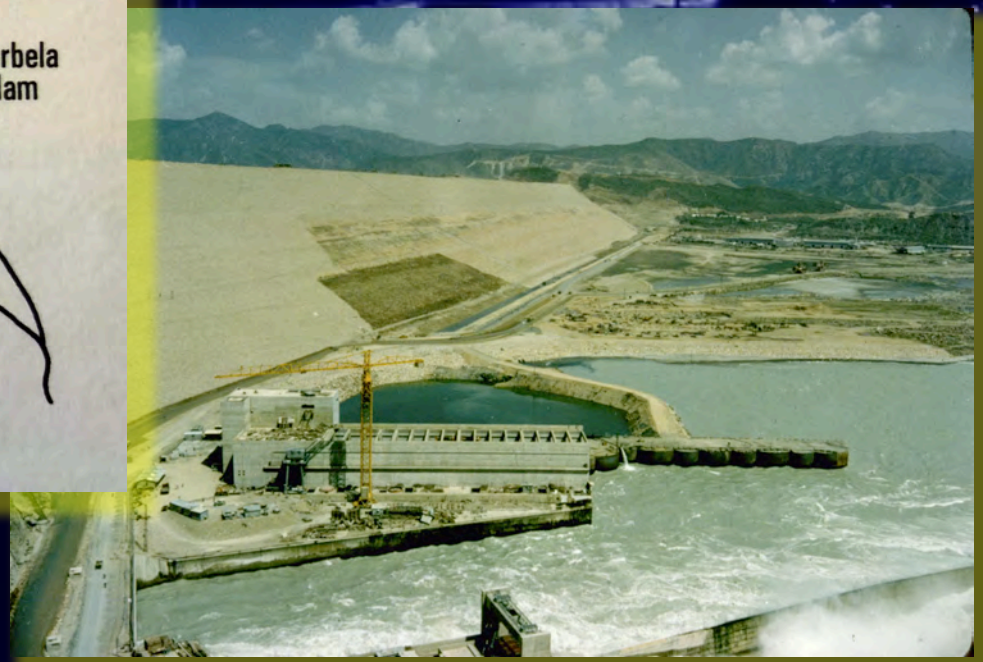


Run-of-river project using large scale settling basins and a storage dam and reservoir for supplying sand-free water to a high head power plant

H&D, Issue one, 2002 pp. 63-68

The critical voice of Sultan Alam
Site selection
Use of diversion dams



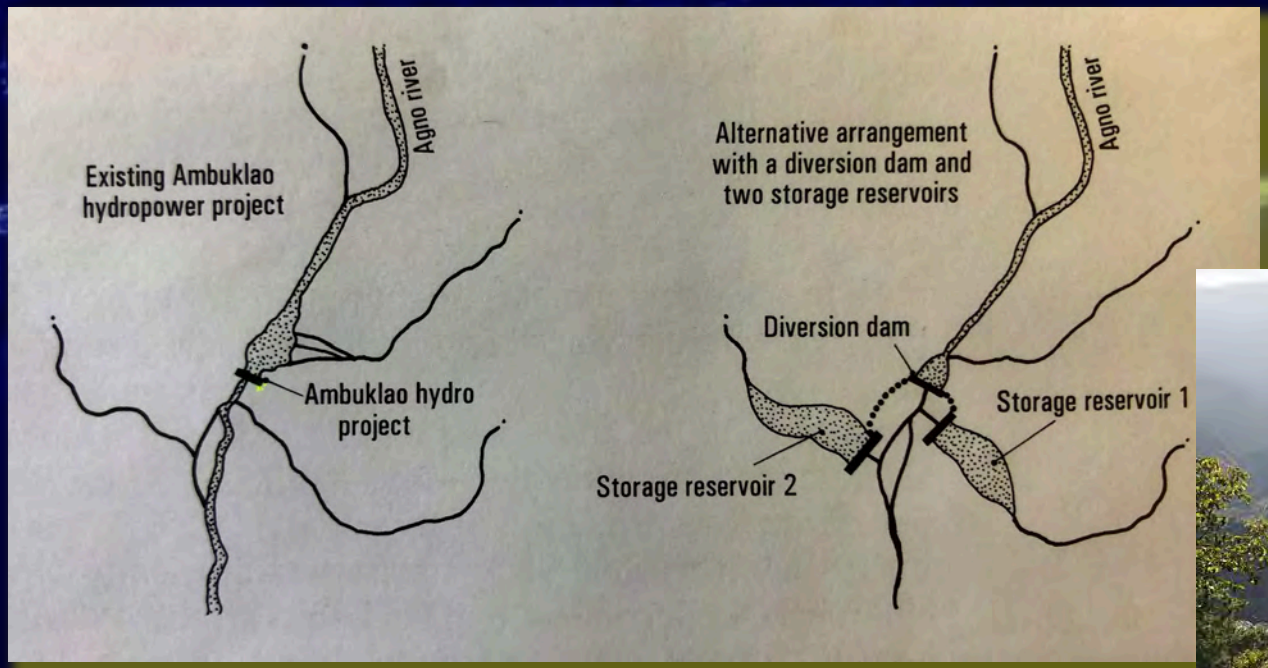


Hypothetical solution for reservoir sedimentation management at Tarbela

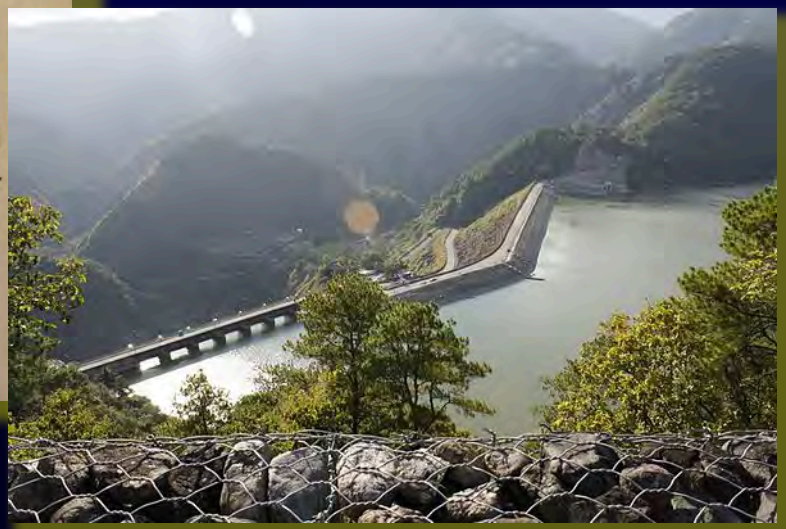
H&D, Issue one, 2002 pp. 63-68

The critical voice of Sultan Alam
Site selection

Combined flow and sediment diversion arrangement and multiple smaller storage reservoirs



Picture Mitchell Yumul



Alternative arrangement with one diversion dam and two storage reservoirs (Ambuklao HP on Agno river, Philippines)

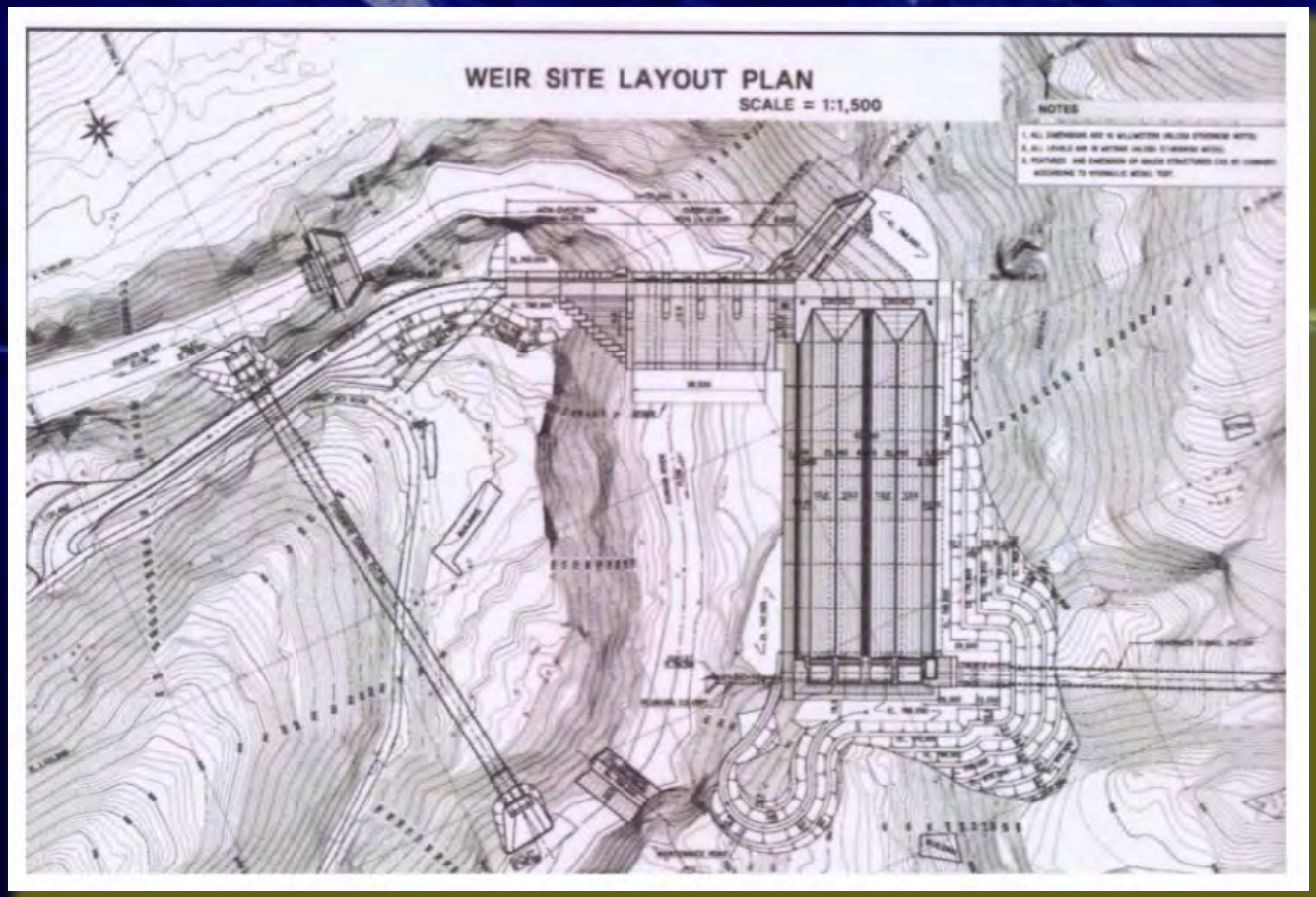
H&D, Issue One, 2002 pp. 63-68

The critical voice of Sultan Alam: Innovative arrangement by using forebays as settlement basin

"There is an urgent need to pay more attention to the problems related to sediment management at hydro projects in many areas of the world, and in particular in the Himalayan regions of Afghanistan, India, Nepal and Pakistan."

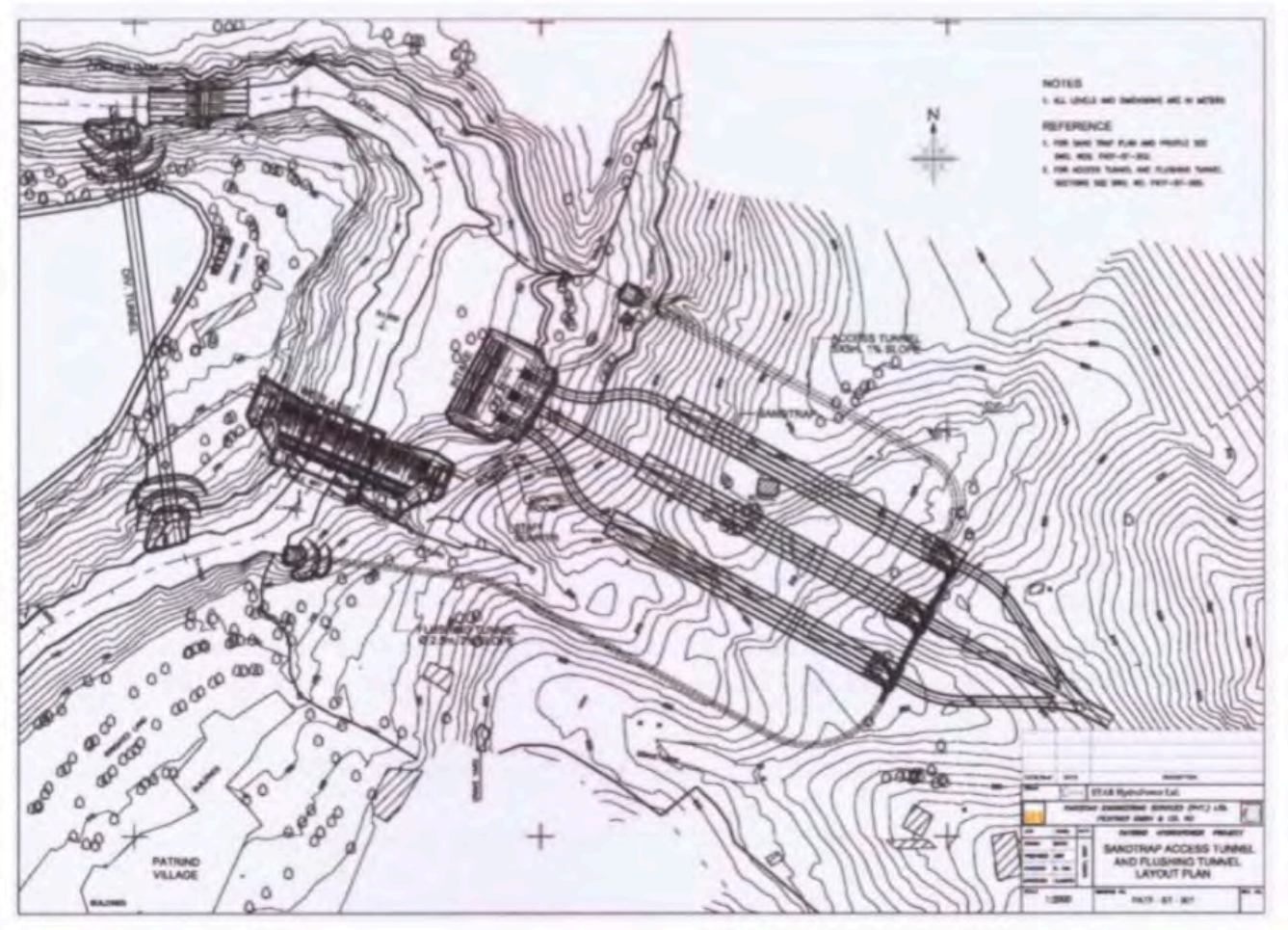
H&D, Issue six, 2005 pp.2-5

The critical voice of Sultan Alam: Innovative arrangement by using forebays as settlement basin



Patrind HPP, Pakistan

The critical voice of Sultan Alam: Innovative arrangement by using forebays as settlement basin



Patrind HPP, Pakistan

The critical voice of Sultan Alam: Innovative arrangement by using forebays as settlement basin

Patrind HPP, Pakistan

The critical voice of Sultan Alam: Innovative arrangement by using forebays as settlement basin

"We hope in designing future hydropower projects in sediment rich rivers transporting high concentration of quartz sand like in the Himalayan Rivers, the project designers will give more attention to the river channel layout which would enable them to use the forebay area as the de-sander by diverting all annual flood discharge in excess of the turbine discharge away from the intake area."

The critical voice of Sultan Alam: Assessment of sediment load and characteristics of sediment material

"Precise knowledge about suspended sediment concentration and the characteristics of the total sediment load that is being transported into the reservoir are essential"

H&D, Issue One, 2002 pp. 63-68

The critical voice of Sultan Alam: Management practice relating to sedimentation

A. *"Run-of-river diversion dams with low river flows, transporting medium to small boulders/sand in medium quantities"*
B. *Run-of-river dams and reservoirs with fairly high river flows and high sediment discharge of gravel/sands*
C. *Large dams (50-100 m high) and reservoirs with fairly large river flows and seasonal sediment loads of mostly fines*
D. *Large dams (>100m) and reservoirs with significant level variations, large flood discharges and annual sediment transport volumes, consisting of fine sand and silt"*

H&D, Issue One, 2002 pp. 63-68

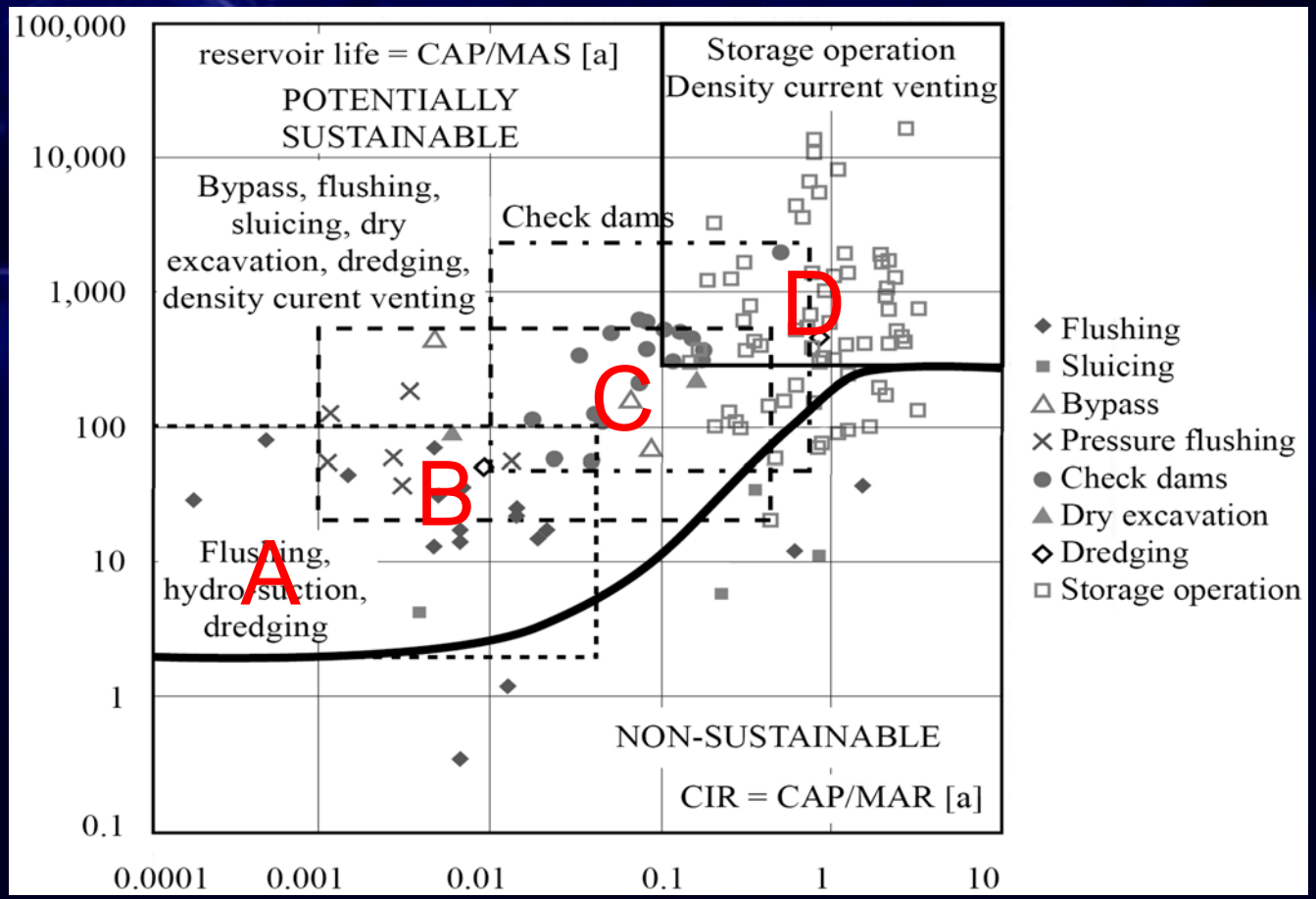
The critical voice of Sultan Alam: Management practice relating to sedimentation

Mean Annual Sediment inflow volume
(MAS)

Mean Annual Runoff
(MAR)
Reservoir Volume
(CAP)

Reservoir live
CAP/MAS

Capacity-Inflow Ratio
CIR=CAP/MAR



The critical voice of Sultan Alam: Small-scale physical models and/or numerical models to validate concepts

"Distorted small-scale physical models, although qualitative in nature, can provide very valuable information regarding sediment transport patterns along the reservoir in a quantitative manner which is adequate for design purposes."

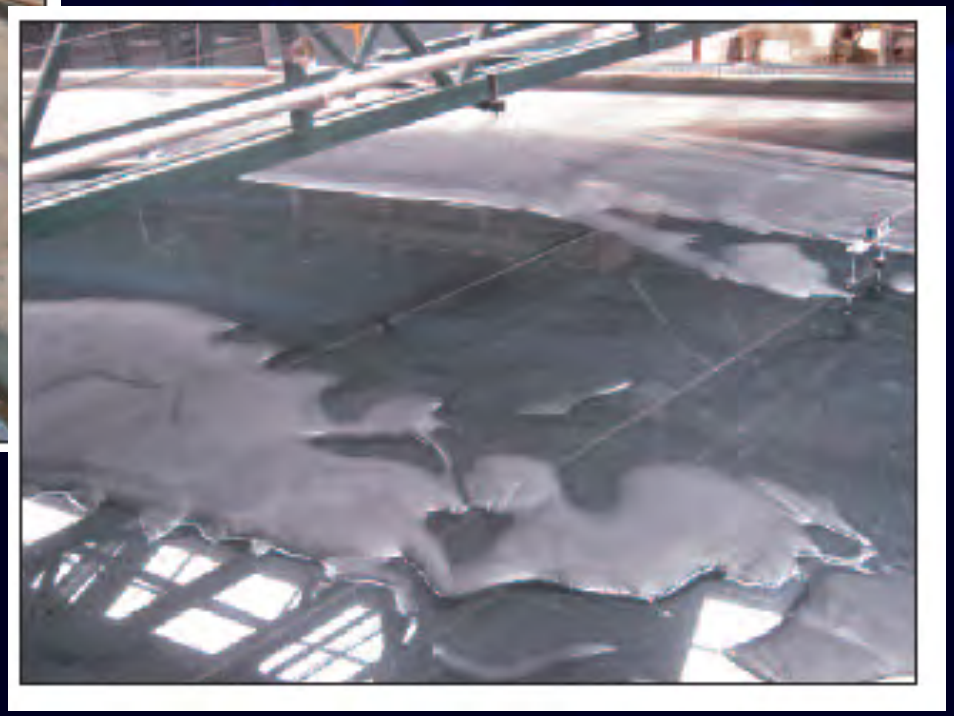
Such models are very economical and can reproduce many years or decades of complex reservoir operation within a very short time period

H&D, Issue Six, 2006 pp. 1-5
H&D, Issue One, 2001, pp. 54 - 59

The critical voice of Sultan Alam: Small-scale physical models and/or numerical models to validate concepts

Jirau HPP, Brazil – Run-of-river low head

Material density 1.05 and grain size distribution curve 0.1 to 0.8 mm



The model presents 20 km of the Madeira river upstream of the project and 10 km downstream with a distorted scale of 1/1000 horizontal and 1/100 vertical

H&D, Issue Six, 2010 pp. 106 - 111

Reservoirs cannot complain themselves to be overfed with sediments!

They needed the critical voice of Sultan Alam and will need it urgently in future!

Announcement of *Sultan Alam Award*