

Environmental Flows for a Regulated River under a New Hydro Scheme



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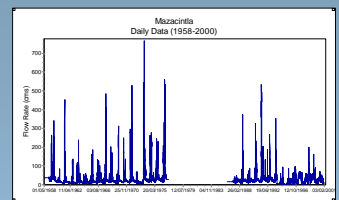
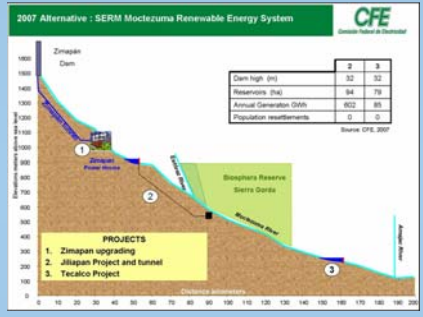
Introduction:

After eleven years of operation of a large dam (Zimapan Dam) without provision on environmental flows, in the upper Moctezuma River in central Mexico, a new hydro scheme (The Renewable Energy System for the Moctezuma River **SERM**) is being assessed with two potential generation sites downstream. The influence area of these two sites has been limited to 190 km of the river until an important tributary is incorporated. A new strategy for environmental flows for the site 2 which can improve the present condition for the aquatic ecosystem in 34 km of the river is being reviewed for the an interdisciplinary group.

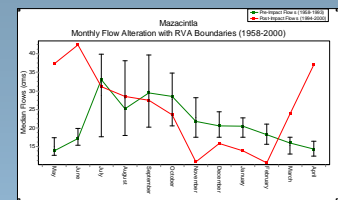


The new proposed hydro scheme:

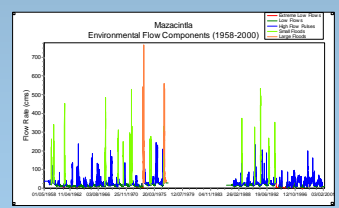
The new first hydro is 13 km downstream the Zimapan discharge. The dam is 32 m high with a small reservoir of 92 ha and 8 km long (7,550 hm³). 26 cms are going to be diverted by a 20 km tunnel to reach the river again 34 km downstream.



Regime flow before and After Zimapan



Hydrologic alterations Monthly RVA Pre – post reservoir



Environmental Flow Components (medians cms)

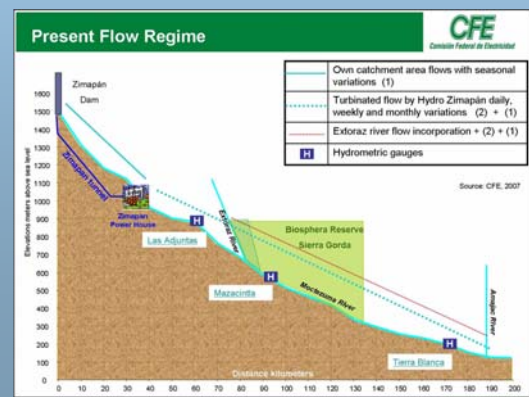
EFC	Pre	Post
Extreme low peak	7.19	5.49
Low Flow	13.75	24.65
High flow pulse peak	34.5	33
Small floods	327	0
High floods	661.5	0

Environmental flows with the new dam

The new strategy for environmental flows downstream the new dam comprises: 23 km with flows between 2.6 to 13 cms (simulated more natural conditions 10% to 50% from dry to rain season- including spills from the dam). The next 11 km , flows are expected from 3.3 to 17.58 cms. This river segment has the highest present biodiversity. Finally, the new discharge from the power house will increase the flows from 29 to 43 cms (from dry to rain season). These flows will have an attenuated impact since they are release in a less step current and mixing more balanced volumes.

Present conditions:

The Zimapán dam was built in 1990-1993. The reservoir was filled during 1994 and 1995. From this last period the flow downstream started being just the one coming from the catchment's area and some springs, since water from the reservoir is diverted by a 21 km tunnel and discharged 42 km downstream the river. The Hydro has been operating for peak energy since 1995 during 4 to 12 hours every day with diary flow variations up to a maximum 59 m³/s when the two turbines are under operation. This flow regime has modified the channel which is now uniformly covered by sand and without refuge, reproduction and feed zones for aquatic fauna. The flooding area is altered too and there are few species in the riparian vegetation.



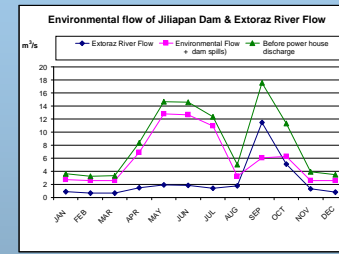
Methods:

Tennant´s approach to obtain minimum flows. IHA –TNC software to identify: 1)The regime flow and environmental flow components, 2) Hydrological alterations after the Zimapán dam and 3) RVA Interdisciplinary discussion to foresee the potential new conditions under the proposed scheme.

Results:

The Las Adjuntas Hydro gauge was discarded because it has few data years and with wide gaps. Mazacintla hydro gauge was then analyzed. Tennant approach results:

Mazacintla Hydro Gauge			
Period	Flow (cms)	Condition	Importance
Driest months (March – May)	3.4	Extreme low flows	Temporal stress
Dry season (November – February)	6.8	Maintenance (acceptable low flows)	Habitat conservation
Rain season (June – August)	20.4	High flow pulses (Hydro period)	Floodplain conservation
Floods (September – October)	54.69	Small floods (Hydro period)	Geomorphologic configuration of river bed
Extraordinary floods (3 days in September)	180	Large floods (Hydro period)	Quick empty



Months	11 km		23 km	
	Ecological Flow from dam (cms)	Spill flows from dam (cms)	Extoraz River Flow (cms)	Flow before Power house (Mazacintla) (cms)
January	2.6	0.12	0.89	3.61
February	2.6	0	0.65	3.25
March	2.6	0	0.7	3.3
April	2.6	4.28	1.46	8.34
May	2.6	10.18	1.91	14.69
June	2.6	10.09	1.87	14.56
July	2.6	8.33	1.41	12.34
August	2.6	0.67	1.79	5.06
September	2.6	3.48	11.5	17.58
October	2.6	3.66	5.1	11.36
November	2.6	0	1.3	3.9
December	2.6	0	0.85	3.45

Conclusions:

At the Las Adjuntas and Mazacintla gauges, the flows will meet 10 percent of the annual average flow (Tennant's approach) specifically for the dry season (Nov to May). It is recommended to simulated small and large floods in the 34 km of river downstream the new project. In doing so, seasonal variations can be expected with potential recovery of the aquatic ecosystem. Using the hydrological indicators (minimum flows and IHA-RVA) a monitoring flow program can be establish for the 34 river segment. A complementary set of indicators for the geomorphologic conditions and the structure and functional groups of ictiofauna are being reviewed by the University of Queretaro for an integrated ecosystem recovery program.