

## Improving the safety of dams and hydraulic structures

Report by Mr Christian KERT, MP

*In February 2007, an alarmist article in 'Capital' took up an internal study by EDF emphasising the insufficiencies in the inspection and maintenance of the safety installations of large French hydraulic dams. It caused great emotion in the population and among the elected representatives of local authorities downstream from dams.*

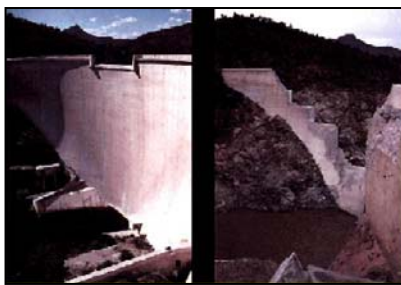
*Is the health of hydraulic dams as bad as this article makes out?*

*Christian KERT - deputy, Bouches-du-Rhône - already a rapporteur for the Parliamentary Office for Science and Technology Assessment for previous studies on the prevention of natural hazards, as well as on the securing of road and rail tunnels, was appointed by the Office to study this issue.*

### Summary

The number of large dams in France has recently been counted: 744 structures over 10 metres high and several thousand structures of a lower size! There are 296 dams over 20 metres high and 448 dams included between 10 and 20 metres. Among these 296 dams, it is also necessary to distinguish the 99 structures – 25 of which are non-hydroelectric – over 20 metres high and having a storage capacity over 15 million cubic metres.

In view of the human and economic activities located downstream and threatened by the energy that would be released in the event of bursting, these structures require strict maintenance, surveillance and inspection.



Malpasset dam - Source : BETCGB

The probability of a dam bursting may be considered as relatively low, but this hazard cannot be neglected given the potential consequences of such an occurrence. During the past century, approximately 1% of large dams have burst, including the Malpasset dam at Fréjus, on 2 December 1959, which caused 423 victims. Since then, the dam safety policy has been mainly based on inspection, by the administration, of the highest dams (over 20 m) and dams particularly concerning public safety, and also on making dam owners aware of their responsibilities.

The decree of 11 December 2007 sets forth the principle of an inventory of dams and reorganises the classification of structures.

While administrative order now reigns 'in the field', some commentators refer to difficulties of application. When assessing the application of this recent text, the need to pay special attention to dykes, in addition to dams, comes to light.

### Despite surveillance and inspection, dams are structures presenting hazards

In effect, dams can face:

- **Floods**, which implies that concrete structures be dimensioned for a millenary flood ;



La Rouvière flood retarding dam during the flood of 9 September 2002 that was higher than its safety project flood. Source: AIGREF no. 19

- **Topographical hazards**, movements or sliding: the issue of the anchorage of dams remains particularly sensitive depending on the nature of the rock;
- **Seisms**, the reference seism in France being magnitude 3.5.



Cracks after an earthquake in China, May 2008 - Source : Bernard Goguel

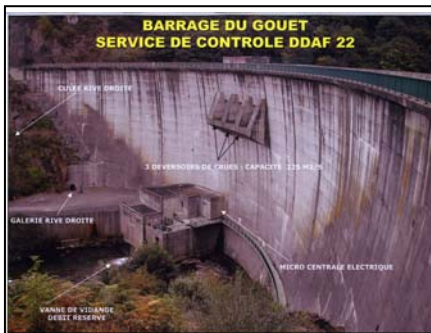
Dams also suffer ageing of their concrete and metallic parts. This has been taken into account in the project to renovate the national hydraulic structures, known as 'Sûreté et Performance de l'hydraulique' (SuPerHydro plan).



Vue aérienne après incident  
Les Tuilières dam - Source : EDF

The safety of the largest French dams is the responsibility, at one and the same time, of their owners, concessionaries, and the agents of the Regional industry, research and environment directorates (DRIRE), whom the rapporteur met.

The rapporteur also took an interest in small dams regarding which it is often no longer correctly remembered who built them or, all the more, who feels responsible for their maintenance.

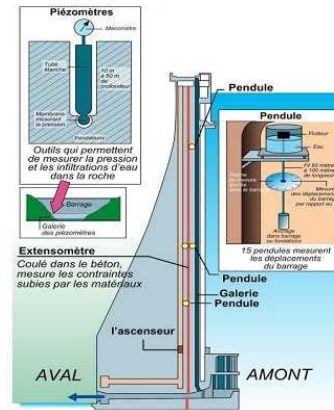


Le Gouet dam - Source : DDAF des Côtes

The world of large dams

➔ Levels of inspection

French surveillance techniques of large dams form a reference for a large number of countries members of the International Commission of Large Dams.



Auscultation tools - Source : EDF

But, unlike France, most big countries have had a single body of inspectors a long time or set up such a body a long time ago. This single body probably allows these inspectors to be better trained in all the techniques and all types of dams.

➔ The seismic hazard

The hypothesis according to which a dam is a structure which, per se, would resist an earthquake better than others is only partially borne out.

China, a highly seismic country, is duty bound to 'prepare' all its structures for a potential earthquake. The recent Sichuan earthquake no doubt caused major damage, but without causing collapses.



Zipingpu dam after the earthquake of 12 May 2008 - Source : Bernard Goguel

A good number of French hydroelectric dams were built in the 1960s and 1970s, at a time when the concern about earthquakes was not perceived as strongly as today.

### A jumbled assortment of small dams

The Gers department alone has 2,850 'dams', some of which are merely small hill dams. This figure provides insight into the extremely diverse situations exposing decision-takers to a variety of unknown factors and uncertainties.

➔ *Does the classification elaborated by the decree of 11 December 2007 allow all situations to be coped with ?*

Class 'D' of dams does not take account of people exposed to the hazard of bursting. While a class 'D' dam forming a hazard for inhabitants can be upgraded to class 'C' or even 'B', this leeway should be more explicit, following the example of what is done for the classification of dykes.

➔ *The funding issue*

If the inventory of small dams brings to the fore a certain number of worrisome cases of obsolescence entailing structural disorders that can impact downstream facilities, what operator will have the financial means to cope with the costs of bringing a dam into conformity?

A certain number of mayors, general councillors, private owners or even small development syndicates do not have, as such, the capacity to fund works they could be required to execute. Some of these structures act as flood regulators, so how can their maintenance be scrimped on?

➔ *Compatibility between texts*

Some owners or mere operators envisage funding rehabilitation by hydraulic developments entailing turbinning the water in their reservoir. Most times, this turbinning contravenes the Act on water which protects biodiversity. What balance can be found between these two contradictory requirements?

The same question arises as to the compatibility of the principles of safety and biodiversity regarding the development of dykes. *'A good dyke is a dyke without any trees or vegetation'*. Vegetation with deep roots forms a handicap for the solidity of a dyke, wherever it is and whatever its size.

➔ *Introducing coherence to the management of dykes*

The same applies to dykes as to dams. Large dyke developments no longer, or almost no longer, raise any problems. Henceforth, powerful development syndicates have taken over from local authorities to bring coherence to 'dyke plans' which alone can ensure the building of solid, uniform, supervised and maintained structures.

However this is not the case with the myriad small-to-medium-sized dykes along watercourses for which the inspecting services must face a multitude of riparian owners – sometimes even encountering the difficulty of identifying these owners – and for which any attempt at coordination appears like the State is exercising a stranglehold on the provinces.

➔ *Dialogue between elected representatives and the departmental administration*

While the exchanges between local elected representatives and the representatives of the inspecting services are generally fruitful and courteous, there are cases when only the personal goodwill of the players allows a salutary dialogue and exchange to be pursued. In the present situation this cannot be otherwise when the administration forces the local elected representatives without providing any practical or financial solutions.

➔ *The environment of dams*

The inventory concerned the state of all French dams. However, the 'environment' of these dams must now be taken into consideration. In effect, since the post-war-years, rural France has changed greatly: roads, lanes, leisure zones, housing estates and small activity zones have been located, as society has changed, downstream from dams, and territorial coordination has not always taken place.

It is necessary to rapidly envisage a coordination of the inventory and programme of work, taking into consideration the presence of human activities within the perimeter of structures.

### Research is continuing and the training of agents is being stepped up

EDF, aware that its heritage of large dams forms, per se, a potential danger, is pursuing its research and training in a certain number of directions:

- Geology: for the foundation of dams and land resistance to earthquakes ;

- Concrete disease. Technicians prefer this terminology to the more journalistic 'concrete cancer'. The most convincing application of this research will be able to be made on the Chambon dam in the Isère department, which is considered a very special case since the concrete had to be 'hacked' so that these cuts serve as a 'dilatation' to the thrust causing the concrete to swell.

Also, the Large dams engineering and inspection department (BETCGB) and the CEMAGREF are proposing training, with tools allowing people to constantly update their knowledge.

## RECOMMENDATIONS

### Large hydraulic dams

1.- The analysis work by EDF engineers, which served as the basis for the press articles and fed the controversy of 2007, referred to dysfunctionings in some dams coming under this Plan and also to some other facilities not covered by it. It must therefore be ensured that there is no 'SuPerHydro 2' but that EDF's budget really does have a sufficient appropriation to ensure appropriate and good quality maintenance, thereby keeping maintenance at a point of balance.

2.- A decree to appear shortly is to amend the prior decrees on the concession and declaration of public interest of structures using hydraulic energy. Its main aim is to define the mechanisms of the process of placing hydraulic concessions in competition. It is mandatory that this text consider that the safety of structures and their operation should form an essential element of applications for renewal. We must be certain about the quality of those who may wish to take over the operation of EDF sites.

### Small dams

3.- As soon as the inventory in 4 classes has been made, as laid down by the decree of 2007, the State services must be required to carry out an audit of the human environment of dams most exposed to a hazard or around which the demographic density or level of activities is such that it may form a natural danger in the event of an incident on a dam. It will lie with the prefects of the departments concerned to take any preventive measure on the basis of the state of health of a dam and the situation of the surrounding human environment.

4.- As part of their 'water policy', the General Councils of the departments most exposed to a 'dams' hazard must take charge financially of the structures of territorial authorities shown to be dangerous by the inventory and the securing of which obviously cannot be assumed financially by these local authorities, given their demographic and financial surface.

5.- For dams belonging to private owners, it will lie with the inspecting authority to demand, after the inventory, the execution of reinforcement, securing and maintenance work within a maximum 5 year period. Beyond this length of time, it will lie with the prefect of the department concerned to demand the execution of this work or order that the structure has become a peril requiring demolition.

### Dykes

6.- A new dyke development policy must be stimulated in France. While the examples of the Rhône or Loire development syndicates are of a nature to reassure, they must not overshadow the lack of an overall policy on a dense network of small-to-medium-sized dykes along watercourses.

A 'good environmental conduct code' should be drawn up regarding the balances to be achieved between the building of solid and effective dykes and respect for territorial ecology.

### Research

7.- Research must be pursued in the field of the seismic resistance of hydraulic structures and, more broadly, for all French dams.

8.- Concrete disease affects a certain number of large dams. The development of techniques does not prevent, for the time being, recent structures from being affected by the alkali reaction or by an internal sulphate reaction. The laboratories working on these 'diseases' must therefore pursue their research and keep the community of dam operators abreast of the progress they make.

9.- Research should take advantage of the creation of the Directorate-general for the prevention of hazards to develop a harmonisation of the inspection and surveillance means and methods. It is legitimate to demand that, given its industrial safety mission, this directorate should strive to create the conditions of unified inspection throughout the territory regarding the teams set in place and the means available to them.

10.- Faced with the possible loss of knowledge, following the slow-down in the construction of new dams, it would be desirable to benefit from foreign expertise. A body of international experts, for in-depth inspections of the ten-year visit type or after a major incident, would guarantee transparency and information of the public.

July 2008