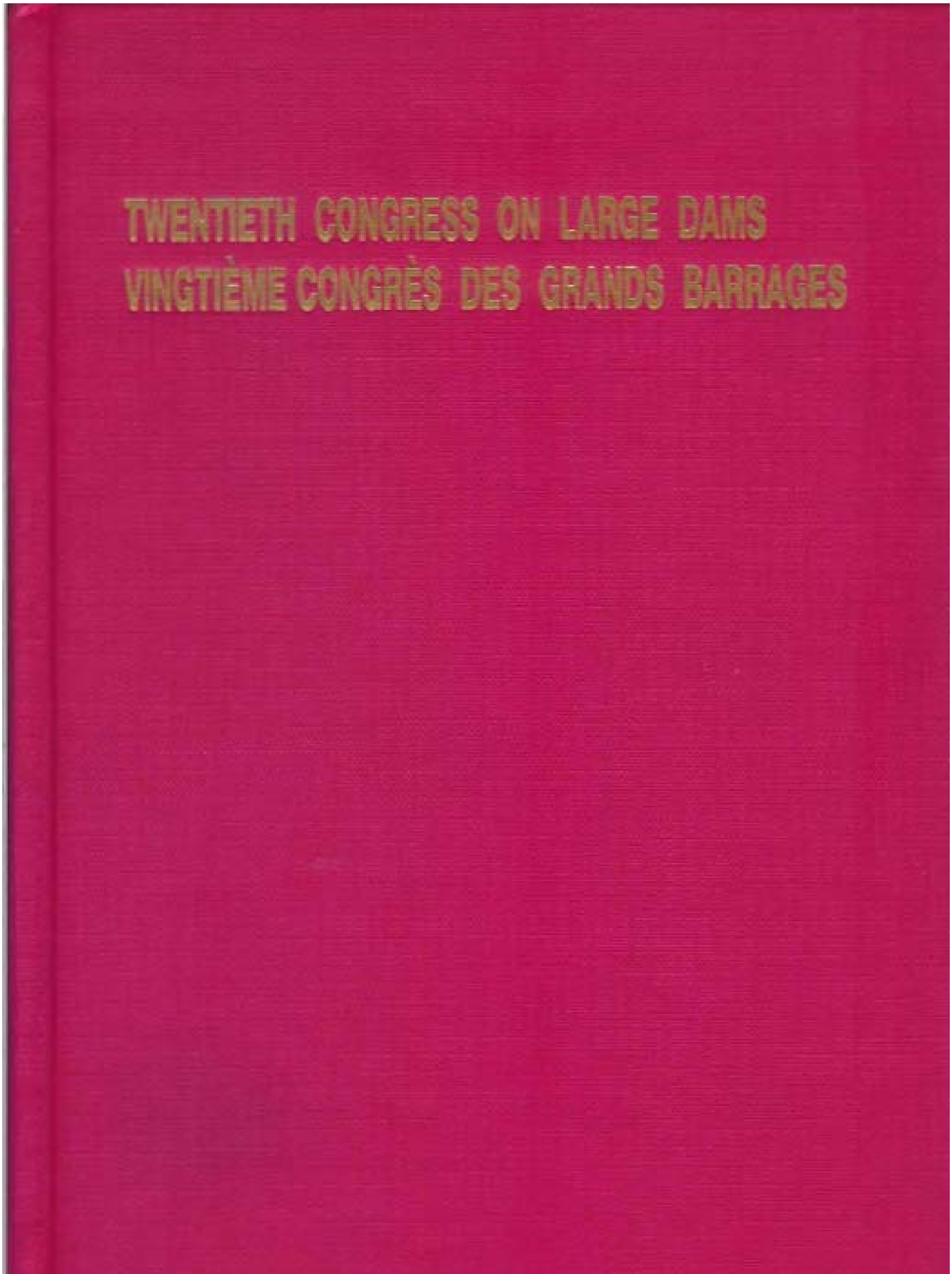

UNCERTAINTY EVALUATION – RISK MANAGEMENT: ACCIDENTS, INCIDENTS, FAILURES, RESPONSIBILITIES, AND COST

COMMISSION INTERNATIONALE
DES GRANDS BARRAGES

VINGTIÈME CONGRÈS
DES GRANDS BARRAGES
Beijing, 2000

UNCERTAINTY EVALUATION – RISK MANAGEMENT: ACCIDENTS, INCIDENTS, FAILURES, RESPONSIBILITIES, AND COST (*)

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1- INTRODUCTION

Up to now, the Model adopted in Brazil for the implementation of infrastructure projects – especially those of hydroelectric developments – followed a pattern with various phases (or projects) as follows:

- Project Feasibility studies,
- Initial Basic (Bidding) Project,
- followed up by a transition Bidding Phase, and
- the Executive Phase, the construction works or the development.

* ***Évaluation des Incertitudes – Gestion des Risques: Accidentes, Incidentes, Félures, Responsabilités, et Coût.***

Generally, during the so-called Basic phase, cost evaluations were conducted somewhat superficially, leaving more profound and detailed studies to a latter phase (a practice expressed in sentences like: "**during the execution of works details will be provided as to...**"). This resulted in modifications to the original project, or inclusion of details that had not been provided for, and consequent cost changes to be shouldered by the Owner.

In the new arena of partnerships, any changes that imply cost variations may be considered as risks. This is a new, unusual practice. Some examples serve as guidelines to set up a framework of points of concern to be addressed during the rolling out of a project.

In order to avoid futile discussions over past issues, some of the examples mentioned were taken from the pertinent literature and are remembered as an exercise for the new practice.

2- IMPORTANT REMINDERS

A great difference brought about by uncertainty analysis lies in the entrepreneur's attitude in attempting to maximize business execution opportunities and minimize uncertainties.

For this purpose, practice has shown that uncertainty analyses are only effective when accomplished by knowledgeable people, with specific experience in each one of the subjects involved. Thus, it is advisable to have a cross-functional team discussing the various subjects.

Uncertainty analysis or risk management is indispensable for risks cannot be altogether eliminated. In face of all this, all the elements involved in the Business Venture must be "acculturated" with respect to the issue. An illustration of how this process can be accomplished is found in Figure 01.

3- TREATING AND LIVING WITH UNCERTAINTY

Since it is not possible to eliminate uncertainty, it is important to know how to live with it, and to see that its consequences are minimized. Basically, one should start by listing and classifying uncertainties according to their nature, as for example:

(a) Contractual
(b) Engineering
(c) Economic-financial
(d) Administrative
(e) Political
(f) Of the Investment itself

Figure 01- Uncertainty Analysis Timing- *(Phase de Analyse d'Incertitude)*

Uncertainty analysis time			
Business Development	Preparation of Offer to the Owner	Negotiation for Contract Signature	Contract Performance
Making the Decision			
Investing in the Bid preparation	Submit a differentiated Bid	Sign contract with the Owner	Manage assumed risks and get ready to take on new ones
Characteristic			
Information of general nature	Budget, Time Schedule and Constructive Methods	Not enough time	Increased responsibility without increase in compensation
Possibility to take part in the process	Owner Wishes	Owner Imposition	
Challenge			
Visualize competitive differential and position with respect to the business	Maximize opportunities and reduce risks	Celebrate the best Contract possible	Overcome expectations; attain better results
What can make a difference			
The Entrepreneur	Basic qualified team	Quick evaluation of new uncertainties created by the Owner	The Entrepreneur
The Owner	Planning		Basic Team of Professionals
The Owner	Contract Administration		

One can then create a spreadsheet for uncertainty evaluation, as shown in Figure 02.

After uncertainties are classified into different groups, qualifications and conditionings follow, in that:

✓ <u>The offer should not include</u> that which was not informed;

✓ <u>The offer should not include</u> that which ***was not requested***

Next, the uncertainty must be handled. This process is summarized in Figure 03.

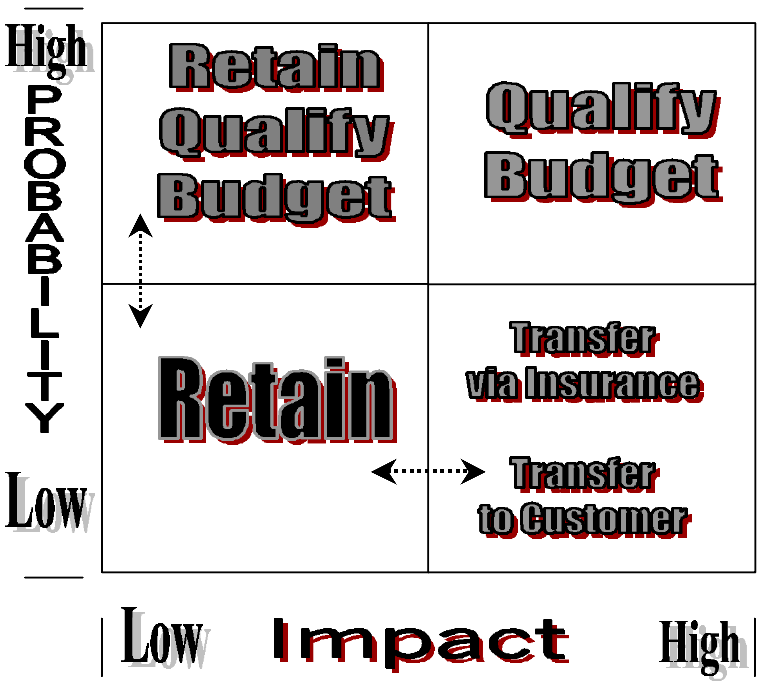
Figure 02- Uncertainty Evaluation- *(Évaluation d'Incertude)*

Uncertainty Evaluation Spreadshee- ***Tableur d'Évaluation d'Incertitude***

(1) Client-Ow ner = Owner scope/Ow ner risk
(Client = Objectif du Client/ Risque du Client)
(2) Vendor = Risk passed on to Vendors
(Vendeur = Risque passé aux Vendeur)
(3) Partner = Risk assumed by Partner
(Partenaire = Risque pris par le Partenaire)
(4) Insured = Risk assumed by third party
(Assurance = Risque pris par des tiers)
(5) Excluded = Not applicable to the project
(Exclu = Ne s'applique pas au projet)
(6) Qualificado = Qualified and/ or conditioned to Bid
(Qualifié = Qualifié et/ou conditionné dan l'Offre)
(7) Probability = Probability of single occurence in %
(Probabilité =Probabilité de survenance de fait singulier, en %)
(8) Contingency = Amounts added to Bid Price
(Contingence = Montants ajoutés au prix offert)
(9) Oportunity = Amounts subtracted from Bid Price
(Opportunité = Montants soustrait du prix offert)

Item- (Num.)	Uncertainty Factor- (Facteur d'Incertitude)	Notes-(Notes)	Amount- (Montant)- ($*1000)	Owner- *Client* (1)	Vendor- *Vendeur* (2)	Partner- *Partenaire* (3)	Insurance- *Assurance* (4)	Excluded- *Exclu* (5)	Qualified- *Qualifié* (6)	Probability- *Probabilité* (7)	Contingency- *Contingence* (+) (8)	Opportunity- *Opportunité* (-) (9)
Folha- (Page)		Sub Totais- (Sous Total)										

Figure 03: Treating Uncertainties- *(Étude d'Icertitude)*



4- ELEMENTS FOR ANALYSIS

4.1- Project

The hydroelectric development is a multiple-purpose project based on: established knowledge, concepts and practices; data from prospecting exercises; laboratory tests and trials; statistical parameters. However, technical literature has scores of examples of structural deficiencies (cracks due to lack of joints, strains for not factoring in materials properties, damages due to unanticipated loads, etc...) and of hydraulic operation deficiencies (erosions due to abrasion and cavitation in spillways, ducts, dissipation basins, etc...) even for projects with many laboratory surveys.

In many cases, these deficiencies result from using Project data at Feasibility Level – i.e. projected information not at all adequate for Global Price dimensioning. It is highly advisable that this evaluation be made according to Basic Level Projects, with reliable information, duly discussed and agreed upon.

The privatization scenario is conductive to time and cost savings, somehow restricting the possibility of carrying out laboratory surveys and, therefore, increasing the potential for risks.

The changes that are bound to happen in the relationship of the various partners also require practice and dynamic actions. Moreover, in many countries[1] dam constructions are “understood” from “aesthetic” perspectives. This possibility must also be analyzed, in that the development should be compatible with the environment.

4.2- Geological – Geotechnical Information

Geological information of the work site – in detail or not – is an important item to be considered. In-depth analysis of this data may lead to changes in the time-schedule and in resources (labor and equipment), and different costs will ensue.

Well-known cases of:

- Foundation levels (presence of cavities, erosions) different from those projected in the original project;
- Presence of expansible materials[2] , and collapsible materials[3];
- Foundation cracks[4];
- Stress/ strain relaxation and instability induced by open air and/or underground excavations;
- Geological faults;
- Deteriorated material in the foundation;

- Occurrence of gypsum, soluble limestone and/or leaching material veins[5];
- Difficulty in utilizing materials with abnormal selections
- Slope instability in the area of the reservoir resulting from variations at the water level in the reservoir[6][7];
- Modification of the grout curtain[8];
- Artesian-flows[9]

are reminders for a list of aspects to be verified for the implementation of the work.

4.3- Hydrology: River Management and Utilization

4.3.1- Hydrology

Hydrological data based on short-time observation statistics can lead to high-risk evaluations and decisions.

Well-known cases of:

- Changes in the flood patterns, such as those that occurred in the beginning of the 80's due to "*El Niño*" phenomenon, which ended up causing a review of frequency studies[10],[11] ;
- Changes in flow rates;
- Changes in Run Off;
- Changes in the flood concentration times;

are also reminders of the need of risk analysis.

4.3.2- River Management

Prior to the privatizations river management typically followed the guidelines and designs already specified by the tender documents. Rarely was there any room for alternatives. The opposite occurs in other countries as the United States[12], where river diversion and management has for a long time been left to the Bidding Contractor, and operation costs are covered by a "Lump Sum". But this **<u>was not practiced</u>** in Brazil.

4.3.3- River Utilization

Global use of a river's potential relies on planning, habits, traditions and needs. Population growth and the search for opportunities create dynamics that must be taken into account for development implementation. Therefore, the possibility of developing other exploratory processes (mining)[13], catching (fishing), water supply (water quality)[14][15], sanitation and recreations must be considered for the development. In addition to the benefits provided in and for themselves, they constitute an important point of attraction. The need to provide for a permanent path to the existing population is also significant. It is important to highlight that according to recent surveys Brazilian indigenous population has increased.

In view of the fact that the statistics provided for events like these are recent and still being developed – with no consolidated practices – responsibilities and risks must be contemplated.

4.4- Climatology

Detailed information about weather conditions around the work site is sometimes considered of little importance for the planning of activities and for the safety of the structures. One should analyze not only precipitation conditions but also factors like humidity and winds (in case the work demands intense pre-fabricated concrete pieces, for example, or the possibility of thermal decompression which may occur when atmospheric-pressure steam curing is used).

4.4.1-Rainfall

The rainfall regime may bring about significant variations in terms of “Feasibility” of earth works, and in the construction works for the river management. Moreover, in works where Roller Compacted Concrete (RCC) is used, in addition to precipitation levels one must take into consideration the timings required for concrete pouring resumption, as the exposed area may require new treatment and/or cleaning of the site. Regularly, RCC sites have a wide-open surface. Other than that, these concerns do not strongly impact the planning of concrete-face rockfill dams.

4.4.2- Temperature

Many times, information on the region’s temperature history, added to the observation of thermal ranges (daily, monthly and yearly) is not given the attention required in establishing concrete structures safety as relates to cracking.

The further we are from the Equator (increase in latitude) and the higher the altitude[16] the greater the temperature range. This produces thermal cycles in the structure concrete, which may lead to initial and superficial cracking, mainly in the case of concrete at early age.

In such regions (greater latitude and / or altitude) average temperatures are usually lower, thus setting a high gradient with the concrete thermal peak applied to the structure.

This allied to a scenario where cracks appear due to the temperature cycles of day (highest temperatures) and night (lowest temperatures), propitiates a situation of more severe cracking, which may reduce safety and life of the structure.

4.4.3- Wind, Insulation and Humidity

These data are rarely considered in the planning and risk analyses of infrastructure works. Premature drying of clay-like materials, shrinkage due to drying and the ensuing cracking of concrete structures should be considered.

4.5- Silting and Vegetation

4.5.1- Sedimentology

Evaluating the quantity of reposition and transported sediments may impact the final performance of the development and, therefore, of the revenue. This situation is aggravated in case of multiple development (energy, perennation, water supply, irrigation, etc.). Sediment history of rivers with prospecting activities may suffer drastic changes.

Also, the idea that[17], *"....Typically, the construction of large reservoirs with great volumes in Brazil presents no problems due to the scarce population and to the low price of the lands to be flooded..."* which used to express the rationale and the reality of past times is currently subject to discussions of a larger scope, with cost, social and environmental implications. For this reason, developments studied more than 10 - 15 years ago must undergo new analyses.

4.5.2- Vegetation

Changes in the vegetation around the watershed impact the area prior to, during and after the development. Like other subjects, only recently have statistics on these changes started to be collected, and this should be taken into consideration.

4.6- Construction Materials

This item should be carefully examined. Typically, both prospecting and surveys of potential quarries are incipiently developed, in that more profound and extensive evaluations are usually left for the execution phase.

4.6.1- Quality

The specialized literature is rife with examples of materials of deficient, incompatible (with other materials), or unexpected behavior, even in large Projects.

Additionally, technical trials required to verify materials soundness and quality as well as their compatibility with the environment usually take a long time to be performed. Usually, accelerated tests are conducted to provide a general guideline, but this practice is somewhat questionable.

Aspects such as:

- Deterioration due to the presence of expansive mineral-clay;
- Alkalis-silica reactivity;
- Alkalis-carbonate reactivity;
- Pyrite existence;
- Stability of certain types of limestone, among other materials,

are extremely important for the development risk considerations.

4.6.2- Availability

Availability of the materials required for the construction, setting up a plan of origin-destination depend on the acceptance and verification of proven statistical data.

Leaving prospecting for the execution phase may lead to higher costs, incompatible with assumed responsibilities.

4.7- Environmental and Social Considerations

The democratic exercise of rights has led to a scenario of greater respect for people's demands. Many times, the logical perspective of engineers conflicts with the large scope of the demands.

This situation is now more delicate than it used to be, creating a need to establish a new approach to the matter. It goes without saying that citizen, communities and nature must be respected in their rights. Therefore, costs and risks ensuing therefrom must be taken into consideration upon project planning. The above mentioned scenario becomes all the more complicated when requirements are changed during the actual execution of the works, after time schedules and costs have been set forth.

4.8- Resources and Time Schedule

The time schedule for the accomplishment of construction works depends heavily on resource availability (human, material, equipment and financial resources). Interruption and discontinuity of works – common practice in Brazil till then – is now an extremely relevant aspect to be considered for risk and cost analysis.

4.9- Construction Methodology

The different methods chosen for the works usually reveal the contractor's practice and/or in the subject. A risk and cost analysis should precede the choice between a well-known practice and a new one, to evaluate the possibility of success and ensuing benefits.

4.10- Quality Control; Supervision and Monitoring

4.10.1-Quality Control

The agencies and entities responsible for technical higher education, particularly in Brazil, have neglected this objective for various reasons.

However, the privatization reality is conducive to placing the responsibility for Quality Control on the Contractor's shoulder – a common practice abroad, still not commonly adopted in Brazil.

Thus imposed, the responsibility becomes doubtful and questionable[18], despite the need to establish a new type of practice.

4.10.2- Supervision

A phenomenon similar to the one mentioned above occurs here. There is a general tendency to consider this relationship to be one of Inspector-Client and not Partner-Associate.

The new scenario calls for new practices. However, while this does not occur, there are many risks and costs involved.

4.10.3- Instrumentation and Monitoring

As mentioned before, relative to other activities, this item deserves especial attention, not least for the fact that it is a long-term activity.

Moreover, in addition to supporting the analysis of the structure safety, instrumentaion propitiates the recycling of technical parameters thus providing for the optimization of future projects.

5- COMMENTS

The changes anticipated for infrastructure works and implementation require nimble action on the part of the various professional groups involved.

Issues that used to be the Owner's responsibility are now shared by the partners, giving rise to a new discussion environment, with new responsibilities and the need to ponder over risks-advantages.

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SUMMARY

The current scenario of partnerships for implementation of infrastructure works inaugurates a new set of practices, skills and responsibilities not yet exercised by the technical community. This set of actions and responsibilities will probably break some bonds, modify "protections", create new habits, encompass new responsibilities.

Professionals from various areas involved in the implementation of heavy works (and multi-activity works) start to re-think their obligations, responsibilities, risks and advantages.

This paper describes some examples and accidents in an attempt to start discussing some relevant issues and to set forth a new type of practice for the development of infrastructure works.

RÉSUMÉ

Le scénario actuel de partnerships pour la mise en place de travaux d'infrastructure fait démarrer um nouvel ensemble de pratiques, de compétences et de responsabilités pas encore entamés par la communauté technique. Cet ensemble d'actions et de responsabilités devra très probablement rompre certains liens, modifier des "protections", créer de nouvelles habitudes, conceptualiser de nouvelles responsabilités.

Les professionnels des plusieurs domaines concernés par l'exécution des travaux lourds (et des multi-activités) commencent à repenser leurs obligations, leurs responsabilités, risques, coûts, ainsi que les avantages qui puissent en survenir.

Cette publication décrit certains exemples et accidents dans le but d'animer une discussion sur quelques questions, de manière à permettre

d'établir une pratique pour le nouveau panorama de développement de travaux d'infrastrucure.