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Restoration and development of the lakes of Tunis and its shores: looking back upon an acceptable form of contract?

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Abstract

In the summer of 2001 an ambitious project that already started in 1984, was completed: the cleaning up, in stages, of the heavily polluted, marine lakes near the city of Tunis. The contractor was asked to come up with a design and to carry out the works of which the eventual result shall be judged afterwards, on the basis of contractually agreed water quality standards to be achieved. If these criteria are not achieved by the end of a period of 2 years and guaranteed for a further period of 5 years, the contractor shall pay a penalty.
May one require from a contractor that he is willing to accept a number of specifications that are broadly governed by nature only, irrespective of the "Design and Build" character of the contract? Is, for these specific set of conditions, just "doing one's best" not enough? And is this type of contract trend-setting for future "environmental" works?
To answer these questions, first of all a review will be given of the struggle between Client and Contractor concerning the ultimate water quality criteria which had to be applied. Subsequently a closer look will be made into general, contractual clauses and expressions as used today with respect to risk management aspects. Examples of the variety of descriptions of risk phenomena will be collected and finally a model for "how to deal with certainties" will be presented. It gives the decision maker a tool to classify more easily risks so that both Client en Contractor can decide on beforehand how they shall share risks in the project to execute.

1. Introduction

Between the city of Tunis and the Gulf of Tunis there exist two lakes: The North Lake and the South Lake, separated by the Navigation Channel. This channel connects the Port of Tunis with Port la Goulette. Both lakes and the channel have been polluted since a very long time both by continuous sewage-water discharges from the city and as a consequence of industrial activities. Both lakes could be seen, from a hydro-biological point of view, as dead systems [1].

The project concerned the redesign and change of the configuration of the lakes and the boundaries of the Port of Tunis. The bottom of the lakes and entrance channels were dredged and the shores cleaned. Tidal gates and a tube-system have been installed. They will enhance and force the flows through the lake. At the same time the Port of Tunis will be flushed and the water will be discharged of via the Navigational Channel and Port la Goulette into the Gulf.
The cleaning activities took place, both technically and contractually, in two different stages. In the period 1984 - 1988 the Northern Lake was cleaned, in the period 1998-2001 the Southern Lake was restored. Both works were carried out by different joint ventures of dredging firms.

The Northern Lake nowadays is a success; the Southern Lake, although just finished, seems to become one. But still there is an unpleasant flavour about the way the environmental aspects were contractually dealt with.

2. The water quality criteria

2.1 The first set of standards

The first question is: Where did they originate? Followed by: Who invented them and were these standards realistic? During the tender stage of the first remediation works for the Northern Lake (1984), the contractor was confronted with a list of water quality criteria in the contract that appeared to be derived from two technical studies [2,3].

Two consultants (A and B) were asked by the Tunisian Employer to advise him (within two weeks!) on criteria to be included in a contract given to contractors for the achievement of an acceptable environment of the lake.
Table 1 shows a summary of the results of both reports and the eventually embodied requirements in the tender documents (differences in bold text).

Note.
Consultant A presented her list by saying that ".....the water quality requirements are feasible for the future. It is expected that the given data can be achieved within a reasonable time (approximately 5 years) after completion of the dredging works". Furthermore they stated in their advice that " A retention period of 30 days for all parts of the lake has to be aimed for".
Actually Consultant B presented her list by stating that ".....provided a flushing rate of not less than 40 m3/s is maintained after completion of the works then a mean water quality complying with the following standards will be readily achieved in the lake".

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Table 1 Original water quality criteria April 1984

Criteria	**Consultant A** (Dec 1983)	**Consultant B** (Dec 1983)	**Employer list** (April 1984)
Dissolved Oxygen	≥ 60%	≥ 60%	≥ 60%
Phosphorus	≤ 0,1 mg /l	< 0,1 mg /l	≤ 0,1 mg /l
BOD5/20	≤ 5 mg/l	**not indicated**	≤ 5 mg/l
Ph	7 - 8	**not indicated**	7 - 8
N_{tot} inorganic	≤ 0,4 mg/l	< 0,4 mg/l	≤ 0,4 mg/l
N_{tot} organic.	≤ 1 mg/l	< 1 mg/l	≤ 1 mg/l
Material in suspense.	≤ 20 mg/l	< 20 mg/l	≤ 20 mg/l
E.coli:			
in non-bathing areas	≤ 1000 / 100 ml	< 1000 / 100 ml	≤ 1000 / 100 ml
in bathing areas	≤ 100 / 100 ml	**< 50 / 100 ml**	≤ 100 / 100 ml
Clarity / Visibility	1 - 1,5 m	**white object 5 cm diameter, visible ≥1,5 m or lake bottom**	white disc 5 cm diameter, visible ≥ 1,5 m or lake bottom
Macro-algae	no floating Ulvae blankets	remove floating algae	no floating Ulvae blankets
Micro-algae (Chlorophyll A)	≤ 20 µg/l	< 20 µg/l	≤ 20 µg/l

Looking at this table, one observes a remarkable similarity as concerns the stringent requirements of both consultants. In any case, the Employer, in casu "Societé de Promotion du Lac de Tunis" (SPL), accepted the presented material and composed a list (in above table) to be given to the contractor, that combined all mentioned parameters with the most stringent criteria of both.

Yet there is some credit to be given to the shorter list (Consultant B). A number of parameters are certainly not independent of each other and consequently there could be too many parameters prescribed to measure the same phenomenon.

For those reasons, the Lake Group, as one of the bidding contractors, attached to its first offer in July 1984, a comprehensive Technical Note discussing, among other things, these matters as follows:

- The complete absence of any statistical approach of the problem is disputable. As a consequence of the unpredictable character of a number of parameters (as a function of time of measurement, weather conditions, procedures etc.) it is more realistic that one accepts a percentual exceedance of e.g. a mean value as a limit instead of one, stone-hard value.

- A combination of standards for suspended matter, visibility and biomass (Chlorophyll A) is peculiar because all three they say something about clarity. Moreover, if clarity increases, the average light intensity will increase, creating circumstances for even more intense bloom of algae.
- The amount of oxygen is rather dependent on the time. Location and depth of sampling. In the early morning it can be almost zero whilst in the afternoon more than 100% (supersaturated).
- The BOD limit originates from the "water purification world" and is more a condition for organic pollution. In combination with the Oxygen standard, this limit is of minor importance.
- In eutrophical lakes a pH of 8,5 to 9 is rather common. A value of 8 as an upper boundary condition is unrealistic.
- Number and location of water sampling points, and frequency of measurements were not given
- Although not explicitly mentioned as a standard but referred to in one of the consultants' reports, the rate of flushing can never be a condition as long as the future Lake content is not known.
- If a low retention time for the lake will be realised, the overall water quality can be hardly better than the flushing water itself, originating from the Bay of Tunis. Consequently, water-sampling points in the Bay shall also be part of the monitoring system (5 points in the Lake) to check the performance of the lake system.

Subsequently, SPL invited bidders (not only the Lake Group had questions) to have informal discussions on a number of issues. From now on, talks took place for two months, concerning the relaxation cq adaptation of the water quality criteria.

2.2 The relaxed criteria

So SPL started a debate on a number of criteria. Adaptations were suggested and considerations presented as partly mentioned already. Various external consultants in this "battle" supported all parties.

In September 1984 the Client defined "the final relaxed water quality criteria" [4] on the basis of which LG made its second and final offer. However, not without comments. In a second Technical Note, attached to the offer, LG stated that they still anticipated a number of difficulties and discussed once more a number of (although relaxed) parameters.

Eventually, the Lake Group became the successful bidder (December 1984), irrespective of minor problems to be solved. Works started as both parties had enough confidence in a good result. During the (design) works the criteria were even more relaxed and demonstrated once more the premature character of the first lists.

Table 2 gives an overview is given of the "final relaxed water quality criteria" (September 1984), and the ultimate list, reported at the end of the design works (Augustus 1985).

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Note.
In September 1984 SPL commented that the Chlorophyll A criterion complies with the criteria for the nutrients and the transparency. The number of reference stations in the Bay was 3. All measurements once per two weeks; in the lake at mid-depth, in the Bay 1 meter below sea surface.

Table 2 Relaxed and ultimate criteria

Criteria	**Employer's list** (April 1984)	**Relaxed criteria** (Sept.1984)	**Ultimate criteria** (Aug.1985)
Dissolved Oxygen	≥ 60%	< 50% in no more than 2 out of 12 (at dawn)	**< 30%** in no more than **4** out of **26** (at dawn)
Phosphorus (total)	≤ 0,1 mg /l	annual av. in lake not to exceed same in Bay by more than 200%	annual av. in lake not to exceed **3 times** same in Bay
BOD5/20	≤ 5 mg/l	**cancelled**	
Ph	7 - 8	≤ 9	unchanged
N_{tot} inorganic	≤ 0,4 mg/l	**changed in:**	see P_{total}
N_{tot} organic.	≤ 1mg/l	N_{total} >> see P_{total}	
		Cancelled	
Material in suspense.	≤ 20 mg/l	**Cancelled**	
E.coli in non-bathing	≤ 1000 / 100 ml	**Cancelled**	
E.coli in bathing	≤ 100 / 100 ml		
Clarity / transparency	white disc 5 cm diameter, visible at ≥ 1,5 m or lake bottom	white disc **25 cm** diameter, visible at ≥ **2 m** in abt. 90% of observe. unless bottom visible (low wind velocities)	unchanged
Macro-algae	no floating Ulvae blankets	obligation to harvest	unchanged
Micro-algae (Chlorophyll A)	≤ 20 µg/l	annual av. ≤ 30 µg/l; 1 out of 12 > 50 µg/l	**annual av. ≤ 30 µg/l**

In addition to the latest list, it was accepted that there is a relation between a number of parameters, to know Chlorophyll A, Phosphate, Nitrate, wind and clarity:

- in case values of P > 35 µg/l or N > 250 µg/l are recorded in the Bay, Chlorophyll measurements at that time in the Lake shall be neglected.
- in case annual values of P < 15 µg/l or N > 120 µg/l are recorded in the Bay; annual fixed values of 50 and 350 respectively are valid in the Lake.

- Transparency readings not valid if average hourly wind-speed exceeds 10 knots for one of the preceding 24 hours.

It is obvious that deliberations between Client and Contractor have led to considerable modifications of the criteria. Some have completely disappeared; others have drastically been changed to more realistic standards taking into account the stochastic behaviour. One certainly could speak of a learning curve after the start of issue of the tender documents till the end of the detailed design stage.

Reviewing the situation, it is however almost unbelievable that a Client, at first instance, obliges a contractor to fulfil environmental criteria based on (obvious) scarce knowledge and information. And that a contractor not only is doing its duty to realize a project but also is punished (!) if the result does not comply with the water quality standards. It would have been even more astonishing if a contractor had accepted these facts just like that! Both parties however, with common sense, succeeded in combining the possible with the desirable. Finally, this first stage of the project (the cleaning of the North Lake) has been realised successfully, both technically and environmentally.

2.3 Maintenance and guarantee

Apart from the water quality criteria as such, something else played a very interesting role. In the beginning of this paper, notice is made of a maintenance period. The Client distinguished between a maintenance period of two years after completion, and a subsequent water quality period of 5 years.

This had also a previous history. In December 1983 the Client was advised as follows by the two Consultants and decided subsequently; see Table 3.

Table 3 Maintenance- and water quality period

Consultant A (Dec.1983)	**Consultant B** (Dec.1983)	**Employer's decision** (April 1984)
It is expected that the given (water quality) data can be achieved within a reasonable time (approx. 5 years) after completion of the dredging works.	The flow once established would steadily remove nutrients from the sediments, which would stabilise over a period of about 2 years.	Water quality to be achieved by the end of the two years maintenance period. These criteria will be maintained for a further five years.

The Client transformed rather vague statements of both consultants into stone-hard conditions. They appeared to be not negotiable during the first stage of the works (the North Lake), see also later on. Fortunately, these criteria as presented in Table 3 have given no problems. The demonstration of success (monitoring

campaigns) was, although laborious and costly, successful. Even the last year of the maintenance period was skipped although paid for (Client's confidence; Contractor's broken spirit?).

3. A fresh start

3.1 The criteria polished

More than 10 years later, at the start of the second part of the project: the restoration of the South Lake, the "new" Employer "Société d'Études et de Promotion de Tunis Sud (SEPTS)" clearly demonstrated the knowledge gathered in the first stage. Again the contractors were confronted with a list of criteria. But this list was much more detailed, more to the point. Table 4 compares the ultimate list of Augustus 1985 (Lake North) with the new list for Lake South.

Table 4 The polished water criteria March 1998

Criteria	**Ultimate criteria** (Aug.1985)	**Polished criteria** (March 1998)
Dissolved Oxygen	< 30% in no more than 4 out of 26 (2-weekly; at dawn)	< 30% in no more than 92% of the 52 weekly measurements / year during two years of maintenance period; afterwards always ≥30%
Phosphorus (total) and Nitrogen (total)	annual av. in lake not to exceed 3 times same in Bay	East / West side of Lake: annual av. in lake not to exceed 2 / 3 times same in Bay
Ph	≤ 9	7 - 9; bi-monthly measured
Clarity / transparency	white disc 25 cm diameter, visible at ≥ 2 m in abt. 90% of observe. unless bottom visible (low wind velocities)	Secci disc 25 cm diameter, visible at ≥ 2 m in 90% of observ. per station unless bottom visible; bi-monthly, mid-day measured (low wind velocities, as before)
Macro-algae	obligation to harvest	No floating algae; Ulva and Enteromorpha. Monthly 10 samples per station with average mass ≤ 0,6 kg/m3 dry mass.
Micro-algae: Chl.A	annual av. ≤ 30 µg/l	annual av. ≤ 10 µg/l

A number of modifications can be noticed:

- There has definitively been made a distinction between the east and the west-side of the lake;
- A more specific condition has been applied for the algae problems;
- Criteria have been refined and tuned

The contractor for the South Lake: "Groupement d'Entreprises Lac Sud 2000", also used experiences gained during the study stages of the previous project, built, during the tender stage, various models to investigate the feasibility of these criteria, made decisions, won the contract and has finalised the works last year.

3.2 Maintenance and guarantee

A final remark concerning the period after completion. In addition to the North lake criteria, the Client offered some relaxation:
"if at the end of the first year of the 5-years water quality period, the results, added to those of the 2-years of the maintenance period, show that the criteria will not be fulfilled, in that case the contractor may take measures to the satisfaction of the Client, to improve the situation without having to pay the penalty".
Within a number of years we will know!

4. Contractual aspects

Learned all this, the following question is raised: "May one require from a contractor that he is willing to accept from a Client a number of specifications, relaxed or not, that are broadly governed by nature only, irrespective of the "Design and Build" character of the contract? Is, for such works, just "doing one's best" not enough?

It is obvious that in the case of a Design & Build contract, the Contractor shall indemnify the Employer against and from all claims in respect of a.o. damage arising by reason of design. But may this cover every type of claim? In other words, there may be claims for which neither the Contractor nor the Employer is entitled to indemnify each other. In this project the Contractor took an enormous risk.

The complicating thing about risks is that there is an uncertainty as regards the events itself (kind, number), the chance of appearance (probability and possibility of forecast) and consequence (amount and kind of damage). These uncertainties play a great role in the way man deals with risks. And often people look after turning uncertainties to certainties.

To this respect De Ridder [5] distinguishes between 4 kinds of uncertainties:

1. Full uncertainties: in this case you don't know if it will happen and if it happens, what to encounter.
2. Conditional uncertainties: in this case one presumes what can be expected but one does not know what really will occur. This kind of uncertainties is mostly described by means of probability distributions.

3. Perceptual uncertainty [6]: in this case one could have very well known what will happen but is underestimated as a consequence of looking at the case from a different angle or professional view.
4. No uncertainty: in this case one knows that it will happen and what will happen.

Furthermore, in the world of contracts one distinguishes other expressions with respect to uncertainty which are mainly connected to liability:
- reasonably foreseeable loss or damage [7]
- unforeseeable operation of the forces of nature [8]
- ability and possibility to avoid shortcomings [9]

All these terms are made in relation to "experienced" contractors and "qualified" consultants with "professional knowledge". Not something to become happy with. But, maybe all these definitions and/or rather vague expressions can be combined in order to arrive at some firm statements with respect to the character of the uncertainty and accompanying risk.

This has been done, as a model, by working with (im)probabilities in a framework presenting increasing probabilities versus increasing consequences (for risk = probability times consequence). In this case the kind and number of events have been neglected.

In these four combinations, see Table 5, words have been proposed to characterize the various risks concerning the event (references are made to examples).

Table 5 Risk of future natural event / human action

		Probability P?
Will it happen? > (questions of expectations) **What will happen?:** V (questions of knowledge)	RATHER DOUBTFUL	ALMOST CERTAIN
HARDLY RECOGNISED **(lacking experience)**	[10] **FULL UNCERTAINTY** - -	[11] **CONDITIONAL UNCERTAINTY** - +
"WELL" KNOWN **(having experience)**	[12] **PERCEPTUAL UNCERTAINTY** + -	[13] **NO UNCERTAINTY** + +

Consequences R?

The difference between *full uncertainty* and *no uncertainty* is that the risk of the first is explicitly not to foreseen (P * R = low) and of the second is 'certain' (P * R = high).
The conformity between *conditional* and *perceptual uncertainties* is that both risks are moderate (P * R = moderate) and reasonably foreseeable.

To my opinion, in an ideal contract these risks shall be dealt with on the basis of this model. The following sharing is proposed:

- risks with respect *to 'full uncertainties'* (hardly recognised and low probability of occurrence) have to be dealt with by the Client; they are guaranteed uncertain;
- risks with respect to likely events (high probability of occurrence and very well known consequences) are on account of the Contractor; they can be quantified;
- events that certainly will happen but you don't know what you will get (lacking experience); have to be dealt with by both parties. It is in most cases possible to qualify the uncertainty e.g. by means of probability distributions and consequently the risk shall be negotiable;
- events that will result into something - to the 'subjective' opinion and judgement of both parties - what you could have expected but there is a low probability of occurrence, shall also be negotiable.

This leads to the following model:

Table 6 Risk model future events

		Probability P?
Will it happen?: > (questions of expectations) **What will happen?:** V (questions of knowledge)	RATHER DOUBTFUL	ALMOST CERTAIN
HARDLY RECOGNISED	**CLIENTS' RISK** (not to foreseen)	**NEGOTIABLE** (foreseeable)
WELL KNOWN	**NEGOTIABLE** (reasonably foreseeable)	**CONTRACTORS' RISK** (to foreseen)

Consequences R?

5. Conclusions

At the beginning of this article some questions were raised:

- May one require from a contractor that he is willing to accept a number of specifications that are broadly governed by nature only, irrespective of the "Design and Build" character of the contract?
- Is, for these specific set of conditions, just "doing one's best" not enough?
- And is this type of contract trend-setting for future "environmental" works?

In the case of project Lac Nord it was the first time (as far as is known) that a contract with explicit environmental criteria was connected with a penalty in case of negative results. Just the fact that both the Client and the Contractor had great difficulties in jumping to an agreement concerning the ecological feasibility in realising the proper flushing system, demonstrates that nature cannot be looked at in one, acceptable, correct way. A lot of things that happen in nature are hardly predictable. Despite of sophisticated models, even forecasting of such a 'simple' thing as the weather gives us still problems.

Parties had different meanings about this. Actually the full responsibility for the design was given to the Contractor while this only should have been done for the technical, physical part (the experienced contractor can handle this so: *Contractor's risk*). For the rest the Contractor had to deal with unqualified (un) certainties. Leaving the fact that exceeding the criteria certainly led to penalties but maybe not to an unacceptable environment! For instance, after some years *sea grass* started to grow in the system. Nobody involved had ever recognized this on beforehand and one could classify this as a *perceptional uncertainty.*

The answer to the first two questions is NO. Consequently, according to the model proposed, the consequences shall be negotiable between Client and Contractor; before, during or after construction!
The last question has no answer yet; we have to wait and see.

References

[1] Noppen, J.P., Development of a monitoring model for a North-African port and lake system - a new design approach -, Proceedings International Harbour Congress Barcelona, Spain, September 2000

[2] HasKoning, Royal Dutch Consulting Engineers and Architects, Pollution du Lac de Tunis Nord, Rapport de Mission et Recommandations, Decembre 1983

[3] WRC Environment, Lake of Tunis Project, Report of a technical Appraisal by the Water Research Centre on behalf of Société promotion du Lac, December 1983

[4] Sir William Halcrow + Partners, on behalf of Client, telexed Tender Information on water quality criteria, September 1984

[5] Ridder, Prof. H.A.J. de e.a., Lecture Notes Organisation of Design Processes, Technical University of Delft, January 2001

[6] Mann, Frederik, Anthropomorphism and related phenomena, © Copyright 1998 Terra Libra Holdings all rights reserved.

Perceptual uncertainty. Perception is an active process of making sense of what's "out there." We are often uncertain of just what we're looking at when it's far away. We often have to go closer or take a closer look before we're satisfied with the accuracy of our perception. All our perception is a form of interpretation and much of it is prone to error. Two people can look at the same situation and give markedly different reports of what happened.

[7] FIDIC Switzerland 1991,The White Book Guide p.26 (Consultancy Agreements)

[8] FIDIC 200 Switzerland, The FIDIC Contracts Guide p.274

[9] RVOI 1998, Model for the Cooperation between Client and Consultant

[10] BBC News Saturday, July 24, 1999 Published at 16:25 GMT 17:25 UK
Tabloid newspapers have added to the attraction for a desirable 1/1/2000 birth date by adding its own lure of huge cash payments to the proud parents of the first millennium baby. This has fuelled fears that a baby boom ***could plunge*** *the National Health Service* ***into chaos.***
>> Author's classification: Full uncertainty; you don't know if it will happen and if it happens, what to encounter.
(afterwards the National Health Service said it had **not experienced** any "significant increase" in the number of maternity bookings around the New Year)

[11] http://www.epa.gov/globalwarming/impacts/index.html
Rising global temperatures ***are expected*** *to raise sea level, and change precipitation and other local climate conditions. Changing regional climate could alter forests, crop yields, and water supplies. It could also affect human health, animals, and many types of ecosystems. Deserts may expand into existing rangelands, and features of some of our National Parks may be permanently altered.*
Most of the United States ***is expected*** *to warm, although sulphates may limit warming in some areas. Scientists currently* ***are unable to determine*** *which parts of the United States will become wetter or drier, but there is likely to be an overall trend toward increased precipitation and evaporation, more intense rainstorms, and drier soils.*
>> Author's classification: conditional uncertainty; one presumes what can be expected but one does not know what really will occur.

[12] http://www.geocities.com/Hollywood/Picture/7954/snowylyrics.html
Lyrics to Anggun's album *Snow on the Sahara*
.....And if we burn away, I'll pray the skies above / For snow to fall on the Sahara. ***Just a wish*** *and I will cover your shoulders / With veils of silk and gold .....*
>> Author classification: perceptual uncertainty; one could have very well known what will happen but is underestimated as a consequence of looking at the case from a different angle or professional view.

[13] IMMA Press Release, Peter Meisenheimer, Senior Research Ecologist, International Marine Mammal Association, 23 November 1999

*"Our research has shown that the harp seal population is **very likely** in decline," said co-author Peter Meisenheimer. "Furthermore, there is **considerable risk** that the population **will be seriously depleted** before a decline is detected by current census methods."*

>> Author classification: no uncertainty; one knows that it will happen and what will happen.