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Safeguarding water resources in the former Soviet Union in an era of transition: establishing water impact assessment (WIA) within the EIA process

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Abstract: The Former Soviet Union (FSU) republics are undergoing an era of transition. Though they have been much neglected in water resource studies, FSU nations represent important foci for attention because many are characterised by scarce water resources, significant climate changes, transitional economies and imposed development projects with substantial water resource implications. Also, many Environmental Impact Assessments (EIAs) have recently been completed in the FSU, prior to the development of their vast oil and gas reserves. It is argued here, however, that the water resource components of EIAs need adapting and strengthening for the new era in the FSU to deliver maximum effectiveness.

This study focuses specifically on first-hand experience of dealing with water resource issues within EIAs for oil and gas pipeline and terminal development in the dry FSU republic of Azerbaijan. Key water resource issues here include the protection of scarce and vulnerable surface and groundwater resources from hydrocarbon contamination and sediment pollution. The 'reverse' hydrological impacts of pipeline river crossing stability and flash-flood risk are also important. The key problems for EIA practice in the FSU include: a focus on multidisciplinarity rather than interdisciplinarity; restrictive *scoping*; limitations of basic water resource data; a virtual collapse of the water resource monitoring network in the early 1990s; the presence of weakly-defined environmental changes; infrastructural/logistical problems in these transitional economies; poorly resourced water resource organisations; and transnational water resource constraints.

To meet these challenges, this paper proposes that a more robust procedure needs to be incorporated within EIAs. This is termed a *Water Impact Assessment (**WIA**)* methodology. ***WIA*** usefully integrates a fresh generation of assessment protocols and pre- and post-project appraisal procedures, including: (1) Incorporation of truly *integrative and holistic* water resources assessments, which specifically consider *interrelations* between environmental components; (2) A more formal evaluation of recent and future *environmental and hydrological changes;* (3) A requirement to monitor *actual* impacts in relation to those *predicted* by the EIA; (4) *Peer review* of the derived Environmental Statements to help maintain quality; (5) Research to develop a *new generation of methods* appropriate to EIA constraints (e.g. time); (6) *Greater input by water resource specialists* during EIA scoping stage; (7) *Increased contact* between local (FSU) and 'western' water resource specialists; (8) Progression from EIA to Environmental and *Social* Impact Assessment (*ESIA*); (9) *More active involvement of hydrologists* in the development of improved EIA Directives; and (10) *More realistic time-frames* to enhance the quality, depth and comprehensiveness of WIAs and EIAs.

Key words: Environmental Impact Assessment; EIA; Water Impact Assessment; WIA; Water Resources; Groundwater; Azerbaijan; Former Soviet Union; FSU; Crude Oil; Gas; Pipelines

1. INTRODUCTION

The Former Soviet Union (FSU) republics have been much neglected in water resource studies. In particular, Azerbaijan represents a very important and interesting focus for attention because it is a semi-arid environment characterised by scarce groundwater resources (Wolfson and Daniell, 1995), significant recent climate changes (Hadiyev, 1996), mountain-lowland juxtapositions, a transitional economy (Bradshaw, 1997), rapid development projects, and a high degree of western involvement in resource exploitation. Also, many Environmental Impact Assessments (EIAs) have recently been completed in the Former Soviet Union (FSU) republics, including Azerbaijan, particularly in relation to the development of its vast oil and gas reserves. It is argued here, however, that the water resource components of EIAs need considerable strengthening for the new era, especially when applied to the transitional economies and changing environments of the Former Soviet Union.

The aim of this paper is to address some of the challenges for water resource protection posed by this era of transition. It focuses especially on the role of water resource identification and impact assessment within the wider EIA process. It identifies some key strengths but also limitations in current EIA protocols. It also proposes that, to meet these challenges, a specific and robust *Water Impact Assessment (WIA*) methodology is required - one that integrates a range of new developments and improvements in both approach and procedure. Examples are drawn from experience dealing with groundwater and surface water quality and quantity issues in EIAs recently completed for oil and gas pipeline and terminal development in the dry FSU republic of Azerbaijan.

2. THE EIA PROCESS

A typical EIA process is shown in Figure 1. EIA is essentially a prediction of the likely environmental effects that a specific development would be expected to produce (e.g. Glasson et al., 1999).

The results of an EIA study are reported in Environmental Statements (ESs or EISs) (Figure 1). ESs are expected to include: a description of the development project; alternatives considered; policy framework; baseline environmental conditions; environmental impact assessment of the development; cumulative impacts; mitigation measures recommended to reduce undesirable impacts to an acceptable level (e.g. Johnson et al., 1999); and a summary of any residual impacts remaining after mitigation techniques are adopted (e.g. Figure 1).

3. RESOURCE EXPLOITATION AND EIA IN AZERBAIJAN

Azerbaijan is an independent state of the FSU, located at the borders of Europe and Asia between Russia and Iran. Azerbaijan is a semi-arid country: mean annual precipitation varies from c. 400 mm a^{-1} in the west to just 100 mm a^{-1} at the Caspian Sea coastline in the east. Offshore oil and gas resources are vast in Azerbaijan, and the region has attracted substantial exploration and development activity since the mid-1990s (Efendiyeva, 2000; Saiko, 2001), with much further work programmed for the coming decade. Oil is extracted from submarine drilling fields in the Caspian Sea to Sangachal terminal, just south of the capital, Baku, in eastern Azerbaijan. From there is it piped from Azerbaijan to Russia via the Northern Route Export Pipeline and, in a second line, via the Western Route Export Pipeline across Azerbaijan into Georgia to the Supsa oil terminal on the Black Sea, from where it is transferred to tankers destined for western markets. Further transnational oil and gas pipelines are currently being planned and are at the EIA stage (May 2002).

Much of the oil and gas resource development in Azerbaijan is funded by loans from the World Bank. The loans are conditional upon the agencies carrying out, to western standards, EIAs of oil exploitation developments. This includes exploration and drilling, and building, operation, maintenance and decommissioning of pipelines, terminals and other infrastructure.

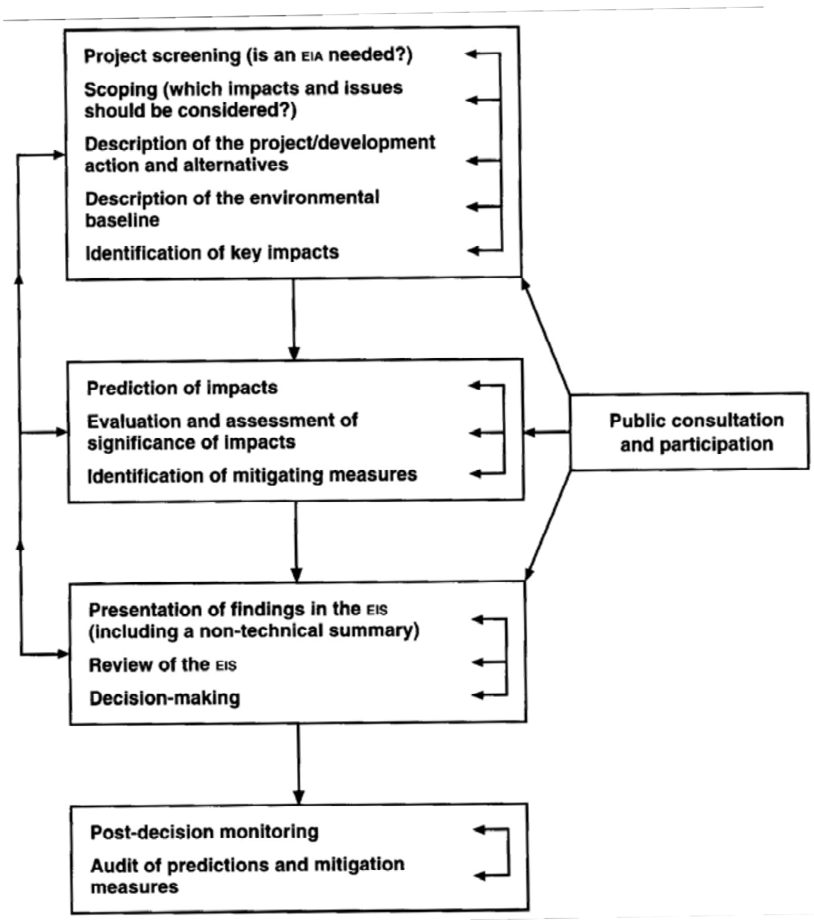

Figure 1. A typical Environmental Impact Assessment (EIA) process (from Glasson et al., 1999)

4. KEY WATER RESOURCE IMPACTS

The key water resources to be protected in Azerbaijan include coastal waters (important for sturgeon fisheries), the major river systems, the large Mingechaur Reservoir in the centre of the country, wetlands in the west (Karayazo Wetland), and groundwater supplies. Normally, impacts on the environment have to identified for each stage of refurbishment, construction, operation and decommissioning. Lawler et al. (1996) identified the key impacts of the pipeline construction on water resources include sediment pollution and fuel spillages at river crossings and contaminant ingress to groundwater systems (Figure 2). During 'hydrotesting', pipeline integrity is checked by passing pressurised water through the line to detect leaks, before oil is first pumped through. However, in Azerbaijan, some pipeline routes consisted of old, refurbished pipelines which contain stale crude oil. Clearly, hydrotesting then produces a large volume of contaminated water which needs safe disposal. A method statement has to be agreed for the acceptable disposal of hydrotest water. During pipeline operation, the major concern is possible oil and effluent spills from the pipeline, associated facilities and terminals into rivers, wetland areas and groundwater bodies (e.g. Price, 1996; Figure 2).

Contemporary EIA should also consider the *'reverse'* impacts of the environment on the development. Here, these include the impacts of bank erosion and channel instability on pipeline integrity at river crossings (Lawler et al., 1996). Unprotected pipelines can be undermined, abraded, corroded or even fractured by erosion, high flows and coarse sediment fluxes. In all cases, breaches of pipeline and oil spillage have to be avoided. Finally, flood risk to facilities built on river or coastal floodplains should be evaluated.

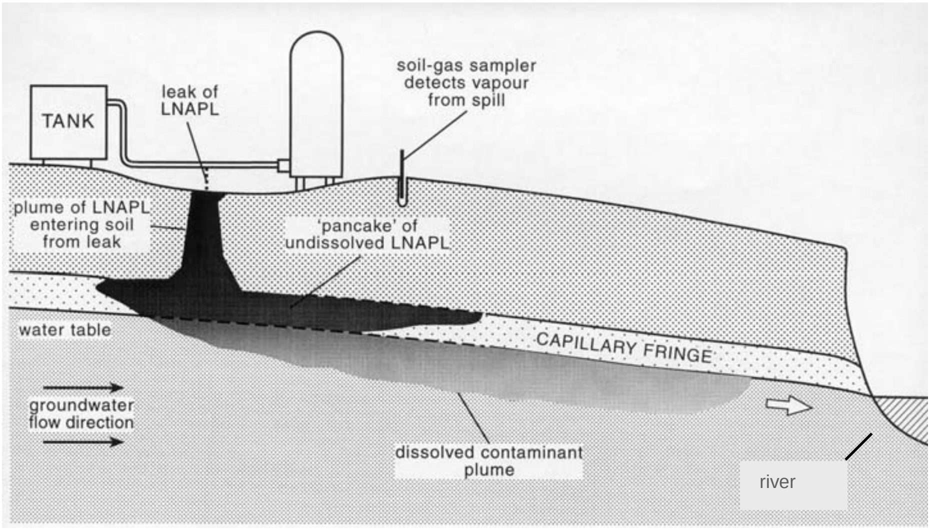

Figure 2. Penetration of LNAPL (Light Non-Aqueous Phase Liquid, such as crude oil) into an aquifer, contaminating groundwater and river water (modified from Price, 1996)

5. DIFFICULTIES WITH EIA IN THE FSU REPUBLICS

A number of strengths of the EIA process in Azerbaijan are identifiable. For example, EIA represents an improvement on previous environmental protection protocols, many of which have been absent or deficient (Micklin, 1988; Saiko, 2001). EIA has also facilitated some development of links between FSU and western scientists, and stimulated new environmental research and analysis (e.g. Figure 3). New environmental mitigation technologies have also been introduced (technology transfer). However, when applying 'western' EIA processes in the FSU, the following limitations can be identified, and these are especially relevant to the water resource impact components:

A. **Limitations of water resource data**. There are considerable uncertainties with information quantity, quality, reliability, processing, confidence limits and appropriateness. For example, although river flow data exist for many gauging stations, sites are often far from the pipeline crossings. Extrapolation and interpolation procedures are made difficult in such semi-arid contexts because spatial environmental gradients are very strong, especially in mountainous territories like Azerbaijan and Georgia. Also, processing techniques underpinning derived measures are often only partially known. Furthermore, metadata (data on available datasets, common in the west) are almost completely absent.

B. **Recent collapse of environmental monitoring networks**. A virtual collapse of the environmental and water resource monitoring networks of Azerbaijan occurred in the early 1990s. This followed immediately after the political, social and economic changes spreading through the FSU republics in the Post-Soviet period of the 1990s (e.g. Bradshaw, 1997). This has led to an acute shortage of *contemporary* water resource data on which to base EIA studies.

C. **The presence of weakly-defined environmental changes**. Azerbaijan has experienced significant recent and historical environmental changes (e.g. Hadiyev, 1996). However, because limited research has been completed, these are weakly defined. It is often difficult to gauge, therefore, the homogeneity of hydrological time series (e.g. Craddock, 1979) or the magnitude and spatial coherence of any changes identified. For example, Figure 3 shows complex trends in groundwater levels in central Azerbaijan. In addition, the most recent changes are very poorly documented because of the dearth of data (see (B) above). In general, EIAs still tend to focus on *baseline* environments, and neglect the evaluation of *recent* and *future* environmental changes (e.g. Krenke and Kravchenko, 1996) predicted over the design life of the project.

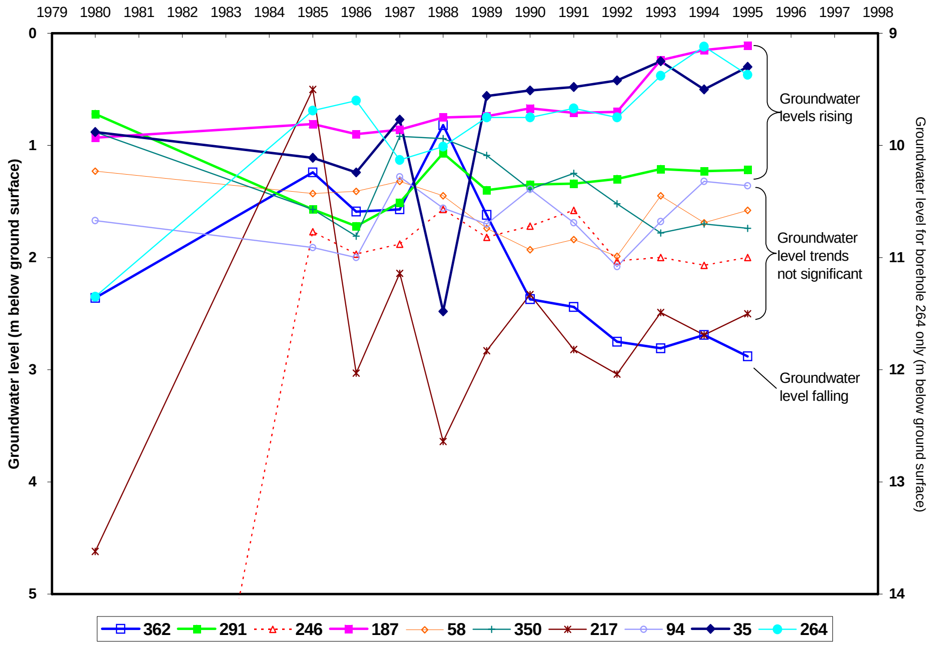

Figure 3. Recent groundwater level changes in the Shirvan Plain, central Azerbaijan, for given borehole numbers (data from Aliev, 1996; analysis developed from Lawler, 1997)

D. **Resources and traditions of water resource organisations**. Existing research traditions and poorly resourced water resource organisations of the FSU can constrain EIA work. EIA runs on a short timescale, and can clash with the conventional, longer-term timescales adopted for FSU and western *research* projects. Azerbaijan organisations lack funding for fieldwork, travel within and outside the country, and analytical support.

E. **Multidisciplinarity versus interdisciplinarity**. O'Riordan (2000) argues that much of environmental science is carried out in a *multidisciplinary*, rather than an *interdisciplinary,* manner. Such compartmentalisation can also happen within the EIA process, where logistics may make it difficult to get different specialists (e.g. freshwater ecologists, hydrogeologists and hydrologists) on site at the same time to work together.

F. **Restricted scoping process**. At the outset of an EIA, a scoping procedure is carried out to select the key environmental 'targets' for special attention in the study (Figure 1), for which time and budgets are then allocated. However, if not carried out thoroughly by specialists with long experience of both hydrological and EIA issues, scoping may lead to a *restricted* and *restrictive* list of sites or issues, which is difficult to expand later unless timetables and funding allow.

G. **Logistical problems in the FSU**. Logistical problems in the FSU can work against comprehensive and efficient EIAs. The transitional economy, infrastructural and, ironically, energy problems in the FSU (e.g. Bradshaw, 1997) can hinder travel and access to remote sites, and the completion of field surveys, water sample processing and data analysis.

H. **Transnational water resources issues**. Rivers and groundwater bodies can cross national boundaries. Although not a problem unique to the FSU, water resource management should embrace all involved governments and authorities, and this may lead to difficulties (Saiko, 2001). The Kura River, for example, the principal water resource of the region, rises in Turkey, crosses into Georgia, then passes into Azerbaijan to discharge to the Caspian Sea.

6. A NEW WIA PROTOCOL FOR EIA IN THE FSU

To meet these challenges, this paper proposes that a more robust procedure needs to be incorporated within EIAs. This is termed a *Water Impact Assessment (**WIA***) methodology, and is especially relevant to the FSU. ***WIA*** integrates a fresh generation of assessment protocols and pre- and post-project appraisal procedures, and includes the following enhancements:

1. **Integrative and holistic water resource assessments**. Incorporation of truly *integrative* and *holistic* water resource assessments, which consider individual water issues and the oft-neglected *interrelations* between them. It also includes 'human' water infrastructure (e.g. drainage and irrigation networks, reservoirs and piped supplies) as well as the 'natural' hydrological systems of rivers and groundwaters. This demands that teams of environmental specialists actually work together, and with regional and national authorities, on focal water resource issues.

2. **Investigation of recent and future hydrological changes**. A key need is for a more formal incorporation of recent and future environmental change (and especially climatic and hydrological changes), at least over the design life of the development project being assessed.

3. **Post-project appraisal**. EIA is essentially a prediction of likely environmental consequences (Figure 1). EIA legislation, therefore, should incorporate the requirement to monitor *actual impacts* of a development in the form of 'post-project appraisal'. Actual impacts can then be related to those *predicted* in the EIA, as a gauge of EIA effectiveness, accuracy and comprehensiveness. Such transparent and comparative exercises, regularly and visibly published, will then form an excellent bank of useful benchmark studies for similar developments in the FSU and elsewhere, for the benefit of *future* EIAs and water resource management schemes.

4. **External peer review of ESs**. New EIA legislation should include provision for constructive external peer review of Environmental Statements by qualified specialists in the fields represented. Peer review has helped to sustain the quality of published scientific work for over a century. It should achieve for ESs the same quality control function as in scientific journals. Reviews could contain commercially sensitive information, and most EIAs are carried out by environmental consultancy companies, so careful thought must be given to its introduction. The reviews should be published to inform interested parties and help to identify strengths and limitations in the *existing* ES, and suggest areas for EIA revision, before planning permission is granted. This should also increase the quality of *future* EIAs and ESs, by allowing stakeholders and contributors to put in place *pre-emptive* Quality Assurance protocols.

5. **New generation of hydrological methods for EIAs**. Research is needed to develop a new generation of methods appropriate to EIA constraints (e.g. time), and for regions like the FSU where baseline environmental and hydrological data are limited. Most techniques in environmental sciences have evolved to deliver results of reasonable accuracy, precision and reliability for the longer timescales of research projects. Where time is short, however, as with EIAs, they may be difficult to apply rigorously. We need new or modified methods, therefore, which deliver robust results when time and data is limited. They may, for example, involve modelling or calibration and correlation against known *standard* techniques.

6. **Introduction of a 'pre-scoping' phase**. Conventionally, scoping for the EIA is completed at an early stage of a project, but often by non-specialists. This creates a list of key topics and sites to be thoroughly investigated. However, for WIA, it is argued that greater input by water resource specialists is needed before scoping is completed. This would ensure that key hydrological

issues are not overlooked and left without appropriate budget or time. This is termed here a 'pre-scoping' phase.

7. **Contact between FSU and 'western' water resource specialists**. Although contact between local (FSU) and 'western' water resource specialists is present in most EIAs experienced, this could be further enhanced. Greater *joint* involvement at scoping, reconnaissance, baseline description, field visits and post-project appraisal stages, in particular, would bring considerable benefits. It would blend the best of local expertise with 'international' scientific analyses and overseas experiences.

8. **From EIA to ESIA**. Moves are now being made to progress from pure EIA to Environmental and *Social* Impact Assessment (*ESIA*). Water resource specialists should play a key role in driving this debate, given their knowledge of water-society relations, the importance of water to human life and water provision as a basic, enshrined human right.

9. **Involvement of hydrologists in development of EIA Directives**. More active involvement of hydrologists in the development of improved EIA Directives would bring great benefits to the process. In particular, a focus on the roles of recent and future hydrological change (because of land-use or climate change), concepts of extreme hydrological seasonality, and spatial-temporal representativeness of site observations could be addressed in future legislation. These issues are best driven by water resource specialists who are regularly dealing with EIA practicalities.

10. **More realistic time-frames for WIAs and EIAs**. Time is very short for EIA projects for many reasons. Future guidance should ensure more realistic time-frames to enhance the quality, depth and comprehensiveness of WIAs and EIAs, including attention to the points itemised above.

7. CONCLUSIONS

Although generally very useful, EIA worldwide has strengths and limitations. From experience with the EIA process applied to energy development projects in the Former Soviet Union republics of Azerbaijan and Georgia, and against a backdrop of an era of transition in the FSU, a number of drawbacks have been identified. Many of these relate to lack of appropriate hydrological data, restrictive scoping, limited interdisciplinary and holistic approaches, and the logistical problems of achieving the necessary work.

In order to enhance the water resource aspects of future EIAs in this era of political, economic, social and environmental change, it is argued here that a new process be incorporated. This is termed here the Water Impact Assessment (WIA) protocol. WIA specifically includes ten components which aim to address some of the existing limitations. The most important issues to incorporate include: holistic water resource assessments; evaluation of recent and future environmental changes; pre-scoping and post-project appraisal phases; external peer review of Environmental Statements; a new generation of appropriate EIA methods; increased contact between local and 'western' water resource specialists; a move to Environmental and Social Impact Assessment; and more realistic time-frames. It is believed that adoption of these measures will significantly improve future EIAs worldwide, and especially in the FSU republics, and help to safeguard water resources.

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