China: Water Supply Three Cities

Ex post evaluation

OECD sector	14020 / Water supply and sanitation – large systems	
BMZ project ID	a) 1994 65 410 (investment in fixed assets) b) 1994 130 (personnel support)	
Project executing agency	Anqing Water Supply Company Bengbu Zhonghuang Water Affairs Cooperation Fuyang Water Supply Company	
Consultant	CES in cooperation with China International Engineering Consulting Corporation	
Year of ex post evaluation	**2007**	
	Project appraisal (planned)	**Ex post evaluation (actual)**
Start of implementation	1st quarter 1994	4th quarter 1996
Period of implementation	60 months	72 months
Investment costs	a) EUR 29.24 million[1] b) EUR 0.20 million	a) EUR 55.50 million b) EUR 0.12 million
Counterpart contribution	a) EUR 16.51 million b) --	a) EUR 43.95 million b) --
Financing, of which FC funds	a) EUR 12.73 million b) EUR 0.20 million	a) EUR 11.55 million b) EUR 0.12 million
Other institutions/donors involved	None	None
Performance rating	3	
• Significance/relevance	2	
• Effectiveness	3	
• Efficiency	3	
• Overarching developmental impact	3	
• Sustainability	3	

Brief description, overall objective and project objectives with indicators

This project on the 'Water Supply Three Cities' comprised the improvement and expansion of the central drinking water supply in the cities of Anqing, Bengbu and Fuyang in Anhui province. In order to achieve its goals, the project proposed the construction of pumping stations, water

[1] This figure does not include the Huaiyin site, which had originally been part of the programme but was taken out very early in the implementation phase at the request of the Chinese counterparts.

transmission lines and treatment plants, including an additional special treatment unit in Bengbu, where raw water is seasonally heavily polluted. The measures were intended to resolve various problems at the different sites:

In the city of Anqing, the project appraisal showed that a large part of the water treatment facilities were completely outdated and no longer economically viable, despite several technical upgrades. This resulted in extremely low water pressure and substantial fluctuation in water quality. Water supplies were affected by frequent breakdowns and capacity constraints.

In the city of Bengbu, the main problem at the outset was that the drinking water supply was using raw water from the River Huai, which was heavily polluted and, in some instances, even containing carcinogenic substances. The incidence of gastrointestinal cancer was significantly higher than in other Chinese cities of comparable size. The waterworks in operation at the time of project appraisal were using conventional treatment facilities (flocculation and sedimentation), which were not sufficiently capable of eliminating the dangerous contaminants. During the dry season, the produced drinking water substantially exceeded national pollution limits.

In the city of Fuyang, the water supply was exclusively based on wells drawing on groundwater reserves. The main problems identified at the project appraisal stage included the excessive use of groundwater resources and the ensuing drop in the groundwater level, resulting in building damage, contamination of the aquifer through the absorption of polluted surface water, reduced production capacity and the drying-up of some wells. Another issue of the groundwater-based water supply was identified during programme implementation, namely contamination resulting from a high natural fluorine content. Fluorine in low concentrations may be beneficial to human health as it reduces tooth decay and hardens the dental enamel. The high concentrations measured in Fuyang, however, led to tooth and bone damage.

Therefore, the project was intended to reduce the health risks to the population. In addition, the project aimed to secure and improve a crucial production factor for trade and industry (overall objectives). In order to achieve these overall objectives, the project aimed to supply the population with clean and safe drinking water all year round, to increase the connection rate to the water supply network (in Anqing and Fuyang) and to preserve groundwater supplies (in Fuyang) (project objectives).

No indicators were defined to measure the attainment of the overall objectives. Indicators to measure the attainment of the project objectives were defined as follows:

- The produced drinking water was to comply with national quality standards, which essentially correspond to WHO recommendations.
- The connection rate was to increase progressively to 325,700 and 323,700 supplied inhabitants in Anqing and Fuyang respectively by 2005 (up from 179,400 and 164,300 inhabitants in 1990).
- Future peak demand in Anqing and Fuyang was to be met by 2005 on the basis of a demand analysis.

This system of objectives was largely appropriate. In retrospect, however, it would have been pertinent to define the preservation of groundwater supplies in Fuyang as an overall objective. Therefore, the ex post evaluation introduces the following overall objective indicators: a reduction of solved pollutants in the drinking water, including carcinogenic substances, and a decrease in the incidence of cancer (for Bengbu); a reduction of the fluorine content in drinking water, a decrease in the incidence of related diseases, and stabilisation of the groundwater level (for Fuyang). According to the logframe, the indicator for the project objective of meeting peak demand is related to the outcome rather than the attainment of the project objectives. For this reason, it may not be used to assess the attainment of the project objectives. The indicator of

the connection rates does not cover Bengbu. However, the project should aim at least to maintain current supply levels. Therefore, Bengbu is also included in the indicator. No indicator was defined for the project objective of groundwater preservation. As part of the ex post evaluation, this objective is moved to the overall objective level. Formally speaking, there is no indicator to measure the availability of the supply system to the population over the year.

The target group of the project comprised the 1.29 million inhabitants of the three cities (2005).

Project design / major deviations from the original project planning and their main causes

In Anqing, a new waterworks with a daily capacity of 200,000 cubic metres including supply lines were built to replace two completely outdated waterworks. Complementary measures included the expansion of the network and of reservoirs and the renewal of some parts of the network. These measures were implemented as planned. The new waterworks was duly commissioned in December 2000 and has been operating successfully ever since. Utilisation of the 200,000 cubic metres of daily capacity is 66% during peak periods. Full utilisation is expected in 3 to 4 years' time.

In Bengbu, it had been planned at the time of project appraisal to add an extra purification unit to the existing waterworks no. 3, which had a daily capacity of 200,000 cubic metres. The purification unit was to use ozonation and activated carbon filtration to eliminate toxic organic compounds. When new environmental legislation was introduced in 1997, government regulators closed down several plants that had discharged heavily contaminated wastewater into the River Huai. As a result, the raw water quality improved. Active carbon filtration to purify drinking water was deemed to be sufficient, and ozonation plans were shelved. With the benefit of hindsight, the decision against ozonation still makes sense, particularly as the quality of the purified water shows that carbon filtration has always been adequate to ensure that the quality of drinking water complies with quality standards. At the project appraisal stage, no capacity increase had been planned, but during the implementation of the programme the decision was taken to step up the capacity from 200,000 to 400,000 cubic metres per day. This measure was designed to shut down the outdated waterworks no. 2, which was no longer economically viable. But then, the project executing agency increased the capacity of no. 3 to 600,000 cubic metres per day, pointing out that Chinese regulations require any installed capacity to be backed up by standby reserves of the same size. Adding the capacity of no. 2, these regulations are complied with. As a consequence, capacity utilisation at waterworks no. 3 is now running at 36% and 28% during peak and off-peak periods respectively. Another reason for this low level of capacity utilisation is the closure of industrial plants imposed by regulators and the introduction of water-saving technologies. The upgraded waterworks no. 3 was duly commissioned in June 1999 and has been operating successfully ever since.

Fuyang saw the construction of a new waterworks with a purification capacity of 100,000 cubic metres per day, a raw water extraction point at the River Cihuaixin north of the city and a 22-kilometre raw water pipeline from the extraction point to the new waterworks. The construction work was complemented by efforts to expand the network and the reservoirs and rebuild some of the network. The new waterworks was duly commissioned in August 2002. Up to that point, the measures had been running according to the plan that had been drawn up at the project appraisal stage. Then, while the construction work was underway, Fuyang's city government changed its water supply concept. Rather than using the new waterworks to supply the whole city, the city government decided to connect only the new, eastern part of the city, where the main industrial estate is situated. The city centre and the remaining parts of the city on the opposite bank of the river would continue to be supplied by the old groundwater waterworks. As a consequence, capacity utilisation at the new waterworks is now running at no more than 27%

during peak periods, the substitution of groundwater abstraction has reached a level of only 13%, and some of the population is still receiving fluorine-contaminated water from the old waterworks.

All three waterworks funded by the programme extract raw water from rivers and purify it for human consumption, using internationally recognised methods like flocculation, sedimentation, filtration and chlorination. The construction work, which was carried out by specialised Chinese contractors, and the electromechanical equipment supplied from Germany (particularly pumps, fittings, chlorination units, instrumentation and control systems and spare parts) are all of good quality. The staff of the three waterworks were trained in Germany under a further training programme. Suppliers instructed the staff on how to operate the equipment.

The programme measures in Anqing and Bengbu were appropriate to resolve the core issue of health risks to the population. From today's point of view, the project would be implemented in both cities in more or less the same manner. In principle, this would also apply to the Fuyang waterworks, if the city government had been acting according to plan, but this is not the case. In retrospect, the facilities should have been planned on a smaller scale.

Key results of the impact analysis and performance rating

All in all, the Anqing facilities are operating to plan. In general, the various parts of the facilities function smoothly and are in good maintenance order. The only issue is that spare parts are stored in insufficient quantities. The connection rate has kept up with the strong population growth (of approximately 50% in the city area). The water supply system is operational around the clock. Raw and purified waters comply with the strict Chinese drinking water legislation. Total losses are within acceptable limits.

The Bengbu facilities are running smoothly, and operation is optimised on an ongoing basis wherever possible. Solid operating processes have been established and are being implemented according to the operating manuals. Activated carbon filters were last used in 2003, as raw water quality has improved. Raw water and purified water comply with the strict Chinese drinking water legislation. Plant maintenance is undertaken on the basis of annual schedules, which provide not only for curative maintenance but also for preventive maintenance. This results in a good physical state of the system facilities and ensures that the water supply system is operational around the clock. An excellent connection rate of 97% has been achieved, and a large number of new connections are installed every year. Water losses are considerably lower than the national standard requirement of 18%.

In Fuyang, the operation of the programme facilities is satisfactory, but utilisation rates are unsatisfactory (and the connection rate is no more than 17%). Customers are supplied with water around the clock. The facilities are in satisfactory condition, but losses of over 50% are unacceptably high. As regards the product, the purified water from the waterworks built under the programme has always been in compliance with Chinese standards.

The project had a certain potential to promote gender equality. This is not so much due to a reduction in the time and physical energy expended in fetching water (since household connections and groundwater wells in courtyards were available before the project started); it is rather due to the reduced workload for women who care for ill people (some of whom are suffering from severe diseases).

The programme did not pursue any direct or indirect goals in poverty reduction and was not aimed at promoting good governance or participatory approaches.

The environmental project objective that was defined at the appraisal stage was 'to preserve the groundwater resources in Fuyang'. The construction of the waterworks under the programme provided a strong foundation for achieving that goal, and when the system of objectives was modified, the preservation of groundwater supplies was moved to the overall objective level. But since only part of the city has, so far, been connected to the new waterworks, only a small contribution has been made to preserving groundwater resources, and the level of goal attainment is still too low.

The following summary of the developmental evaluation should be seen against the backdrop that one third of total project funds were invested in a water supply system which, due to a decision by Fuyang's city government, is now operating at low utilisation levels and has not contributed to resolving the problems which had been identified in the city centre. By normal evaluation standards, the developmental effectiveness of the entire project would have to be rated as slightly insufficient (rating 4). Yet the project has succeeded in supplying almost as many people with clean drinking water as had been planned at the project appraisal stage. This has been achieved as a result of higher connection rates and strong population growth in the cities of Anqing and Bengbu. What is more, the impact of the Bengbu project facilities (which cover 62% of the programme's target group) deserves to be overweighted, because further spread of carcinogenic substances in the drinking water has been effectively prevented and the incidence of severe gastrointestinal diseases has been substantially reduced. For this reason, we shall rank the positive impact of Bengbu and Anqing and higher than the negative results of Fuyang in the overall rating.

The project addressed the development backlog in drinking water supplies which were insufficient in terms of quality and also quantity (Anqing) and had far-reaching adverse effects on the health situation of the population in Bengbu (cancer), in Fuyang (fluorine-related diseases), and to a lesser extent in Anqing. The project design and the measures that were implemented were based on a logical and clear cause and effect analysis and were appropriate to reach the project objectives in Anqing and Bengbu. Changes in the underlying conditions such as the improvement in the surface water quality of the River Huai as a result of new industrial policies in Bengbu were recognised in a timely manner and prompted appropriate amendments to the project design. In Fuyang, by contrast, the influence of local policymakers severely hampered achievement of the overall objectives and the project objectives. The technology that was chosen corresponded to the level of qualification of the operating staff and matched the technological standard of existing water supply facilities. The national sector strategy China has drawn up in cooperation with the Asian Development Bank served as a reference framework for the FC project (e.g. with regard to pricing, private sector involvement etc.). All in all, dividing the labour among the donors makes sense. Despite the adverse effects on the developmental effectiveness that have occurred in Fuyang (and which are evidence of insufficient coherence), the **relevance** of the project is rated as **good (rating 2)**.

The system of objectives was largely appropriate and was modified only slightly during the ex post evaluation. The indicators of water quality improvement and supply system availability were reached by all three project facilities. The indicator of connection rates was exceeded by Anqing and Benbu, while Fuyang underperformed it dramatically, reaching only 17%. All in all, the **effectiveness** of the project is rated only as **satisfactory (rating 3)** due to the very low level of attainment of one of the most important indicators at one site.

The specific investment costs in Anqing and Bengbu were below target (EUR 25 and EUR 6 per person supplied respectively) and are regarded as low. By contrast, they were unreasonably high in Fuyang, amounting to EUR 170 per person supplied, which was 6 times higher than had been budgeted at project appraisal. Loss rates in Anqing and Bengbu are good by FC evaluation standards, but not so in Fuyang. The low capacity utilisation at all three sites may, on the one hand, be ascribed to Chinese regulations, which require any installed capacity to be

backed up by corresponding reserve capacities. On the other, low capacity utilisation is due to reduced demand from industry and more economical usage on the part of individual households following the introduction of individual water metering. In Fuyang, local decision-makers, too, are responsible for the extremely low capacity utilisation level. At current water prices (which take account of social criteria), the low capacity utilisation levels do not have any negative effect on the financial situation of the Anqing and Bengbu operations. However, prices could certainly decrease if the plants were to operate at high utilisation levels. In Fuyang, the poor financial situation of the project executing agency can certainly be attributed to the low utilisation levels. Billing and collection are very efficient in all three systems. The annual financial statements and dynamic actual costing show full cost coverage for Bengbu and a very high degree of cost coverage for Anqing. Compared to other developing countries, this is a very good result for Bengbu and a good result for Anqing. By contrast, the Fuyang operator can cover neither its fixed operating costs nor its variable operating costs. In summary, the levels of efficiency of the Anqing and Bengbu waterworks have largely met our expectations. However, the Fuyang site's efficiency is clearly insufficient, in spite of positive results in some areas. All told, the efficiency performance falls short of our expectations, even though the positive results prevail. This is why we rate the **efficiency** as **satisfactory (rating 3)**.

As regards the reduction of health risks to the population in Anqing and Bengbu, the project has produced the overall effects that had been intended. A review of health statistics and interviews with physicians in Anqing and Bengbu do not show any significant incidence of water-induced diseases. In Fuyang, there is a high incidence of tooth and renal diseases, which may be attributed to the high fluorine contamination in drinking water from groundwater sources. As continuous consumption leads to a build-up of fluorine in the body, long-term damage to the skeleton cannot be ruled out. This may be due to high fluorine concentrations in some of the groundwater sources situated in the north. What is more, the groundwater quality of privately used wells has never been examined and could also be a potential health hazard to the population. The objective of securing and improving a crucial production factor has been achieved by providing sufficient quantities of drinking water in Anqing and Bengbu. In Fuyang, the contribution of the project to this objective is very low, and a very large proportion of industrial water continues to be extracted from private wells. The objective of preserving the groundwater resources in Fuyang has not been achieved, as the project facility has failed to replace the groundwater-based waterworks and covers only a small proportion of overall demand. The **overarching impact** is **satisfactory (rating 3)**. This rating is justified by the fact that a total of 1.26 million people (out of a target group of 1.29 million at the time of project appraisal) have benefited from the project and seen their health situation improve.

The project is rated as sustainable from a financial point of view (very high cost coverage) and from a technological point of view (reliable operation, ongoing expansion of the facilities). In Fuyang, some major sustainability risks persist. Therefore, **sustainability** is rated as **satisfactory (rating 3)**.

The **developmental efficacy** of the project is rated as **satisfactory (rating 3)**.

General conclusions and recommendations

The project demonstrates that both privately-owned and public-sector companies can achieve a good performance level if certain requirements are met; these include efficient management structures and a clear-cut corporate strategy, a performance-based incentive system, largely independent decision-making powers for the management, and qualified personnel in leadership positions.

Notes on the methods used to evaluate project success (project rating)

Projects are evaluated on a six-point scale, the criteria being relevance, effectiveness (outcome), "overarching developmental impact" and efficiency. The ratings are also used to arrive at a final assessment of a project's overall developmental efficacy. The scale is as follows:

1 Very good rating that clearly exceeds expectations

2 Good rating fully in line with expectations and without any significant shortcomings

3 Satisfactory rating – project falls short of expectations but the positive results dominate

4 Unsatisfactory rating – significantly below expectations, with negative results dominating despite discernible positive results

5 Clearly inadequate rating – despite some positive partial results the negative results clearly dominate

6 The project has no positive results or the situation has actually deteriorated

A rating of 1 to 3 is a positive assessment and indicates a successful project while a rating of 4 to 6 is a negative assessment and indicates a project which has no sufficiently positive results.

Sustainability is evaluated according to the following four-point scale:

Sustainability level 1 (very good sustainability)

The developmental efficacy of the project (positive to date) is very likely to continue undiminished or even increase.

Sustainability level 2 (good sustainability)

The developmental efficacy of the project (positive to date) is very likely to decline only minimally but remain positive overall. (This is what can normally be expected.)

Sustainability level 3 (satisfactory sustainability)

The developmental efficacy of the project (positive to date) is very likely to decline significantly but remain positive overall. This rating is also assigned if the sustainability of a project is considered inadequate up to the time of the ex post evaluation but is very likely to evolve positively so that the project will ultimately achieve positive developmental efficacy.

Sustainability level 4 (inadequate sustainability)

The developmental efficacy of the project is inadequate up to the time of the ex post evaluation and an improvement is very unlikely. This rating is also assigned if the sustainability that has been positively evaluated to date is very likely to deteriorate severely and no longer meet the level 3 criteria.

The overall rating on the six-point scale is compiled from a weighting of all five individual criteria as appropriate to the project in question. A rating of 1 to 3 indicates a "successful" project while a rating of 4 to 6 indicates an "unsuccessful" project. In using (with a project-specific weighting) the five key factors to form a overall rating, it should be noted that a project can generally only be considered developmentally "successful" if the achievement of the project objective ("effectiveness"), the impact on the overall objective ("overarching developmental impact") and the sustainability are considered at least "satisfactory" (rating 3).