

Impact of tourism on groundwater extraction on the island of Langeoog, Germany

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ABSTRACT

The economy of the Northern German Island of Langeoog is largely dominated by tourism. Water supply depends on the extraction of groundwater from a freshwater lens. Almost three quarters of the groundwater extraction can be attributed directly to tourism. Water demand shows a strong seasonality which mirrors the holiday seasons. The introduction of water-saving household appliances in the 1990s has significantly reduced the water demand. The tendency towards more frequent but shorter vacations may increase water demand again somewhat. So far, extraction has remained sustainable, as stable groundwater levels show.

INTRODUCTION

The island of Langeoog, a barrier island of about 20 km² size, is situated in the Wadden Sea off the North German coast. Water supply depends on the extraction of groundwater from one of three freshwater lenses.

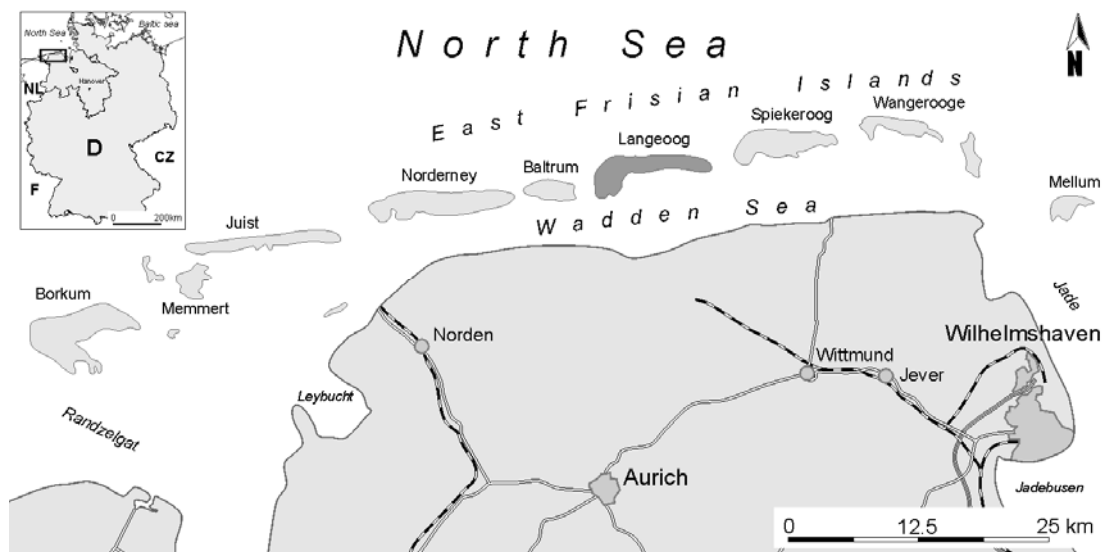


Figure 1. Location map.

Historically, the small population (1885: 202 people) obtained its water from the collection of rain water and from shallow dug wells. Many of the latter were affected by a severe storm flood in 1905. This, and increasing tourism, created demand for a more stable and less vulnerable water supply. In 1909 three wells, 14 to 18 m deep, were drilled in the western freshwater lens, close to the village. They had to be abandoned in 1989 due to microbiological quality problems. Several new wells were drilled from 1938, extracting water from the eastern part of the western lens. In order to prevent upconing of saline water,

extraction today is distributed over 20 small wells, screened from 10 to 18 m below sea level. Pumping is done intermittently at low rates of 10 m³/h per well.

RESULTS

Prior to World War II, water consumption increased due to state-sponsored tourism and construction workers who worked on military installations. Tourism ceased during the war years and consumption leveled off. Immediately after the war, the tourist infrastructure was used to accommodate large numbers of refugees, resulting in a jump in water demand. The post-war network suffered from large losses due to bomb damage, as shown by the difference between extraction and accounted-for consumption (1951 to 1969 data only), but this problem was eliminated until the 1960s (Fig. 2).

Today, Langeoog's economy is almost exclusively dominated by tourism. In 2011 around 1,540,000 overnight stays and 124,000 day visitors were counted. Numbers have remained more or less on this level for the last 20 years, after a steady increase from the 1950s (Fig. 2). The permanent population on the island is about 2,000, with 150 additional seasonal workers during the summer months. Water demand continuously increased until the 1980s, closely following the trend of increasing tourism (Fig. 2). With the implementation of water-saving household appliances (e.g. washing machines, dishwashers) and toilets, which started in the 1990s, consumption significantly decreased. In 2011, extraction was 333,000 m³/a. This is about a quarter less than the peak demand of 452,000 m³/a recorded in 1983, although the number of overnight stays has remained more or less the same since 1990 (Fig. 2).

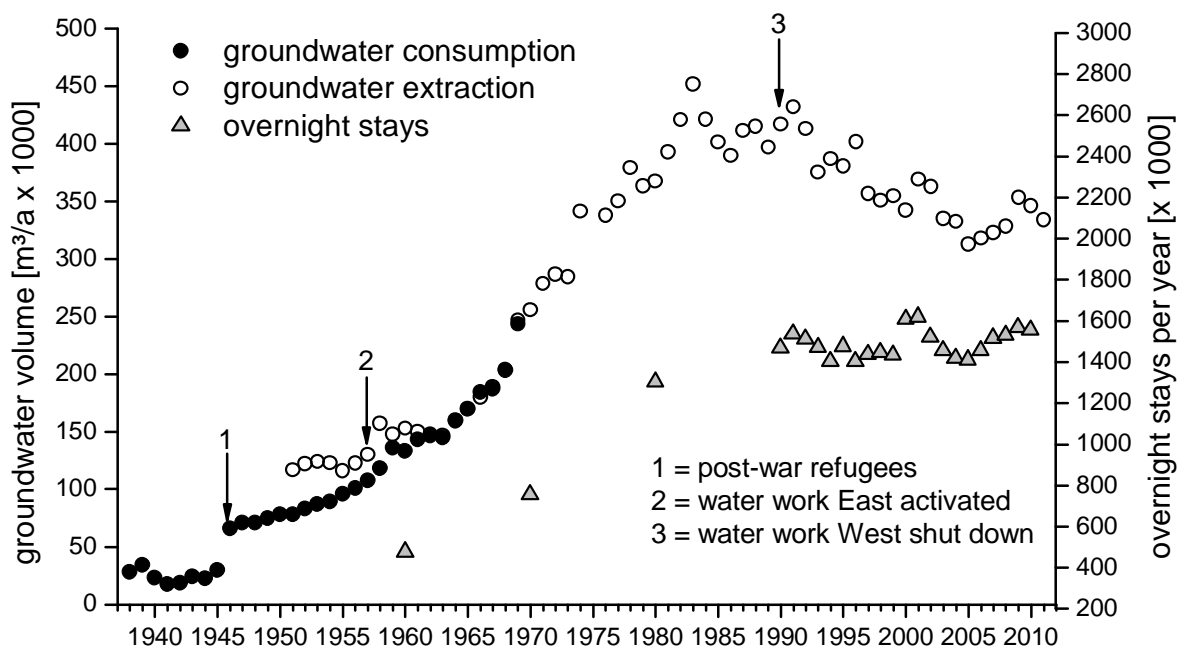


Figure 2. Historical development of groundwater extraction on the island of Langeoog compared to overnight stays (data provided by the water supply company OOWV).

Groundwater levels showed no negative trend during the 1980s when the extraction was at its peak (Fig. 3). With today's lower water demand the system remains stable. Levels reach their minimum during the summer when demand is highest and no recharge occurs but recover during the winter. Groundwater extraction can thus be assumed to be sustainable.

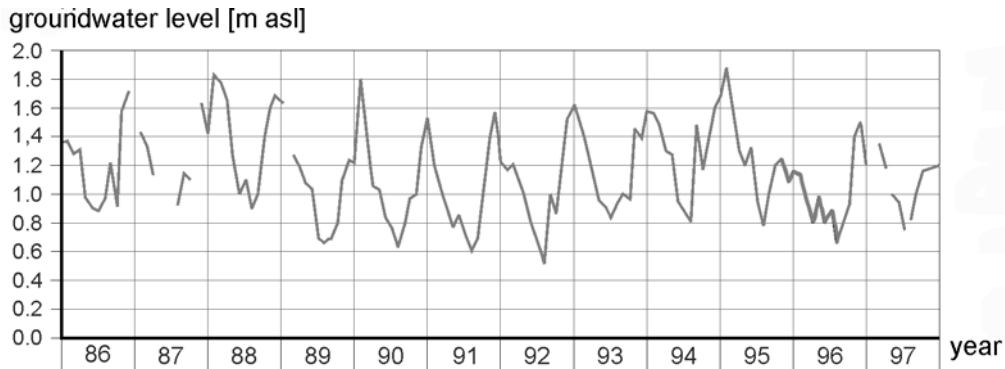


Figure 3. Groundwater levels in an observation borehole on Langeoog (data: OOWV).

Average water consumption in Germany is about 125 liters per day and person, including small businesses. The consumption of the 2000 permanent inhabitants thus amounts to 92,000 m³/a. Subtracting this number from the total consumption in 2011, the remainder of 242,000 m³/a, equivalent to about 72 % of the total, can be attributed directly to tourism. Disregarding the day visitors, one overnight stay corresponds to a consumption of 157 l/d*p. This above average number reflects the need to clean apartments, wash linen/ towels and take showers after a beach day. In the coming years, water saving may partially be compensated by the tendency towards more frequent but shorter vacations (Fig. 4). While a tourist would stay around two weeks in the 1980s, vacations have become significantly shorter, and today guests stay about one week. Since the number of overnight stays has remained more or less constant, this means, that the shorter duration of stay is compensated by more visits (Fig. 4). More frequent changes of guest apartments of course increases the frequency of cleaning apartments and of washing linen and towels.

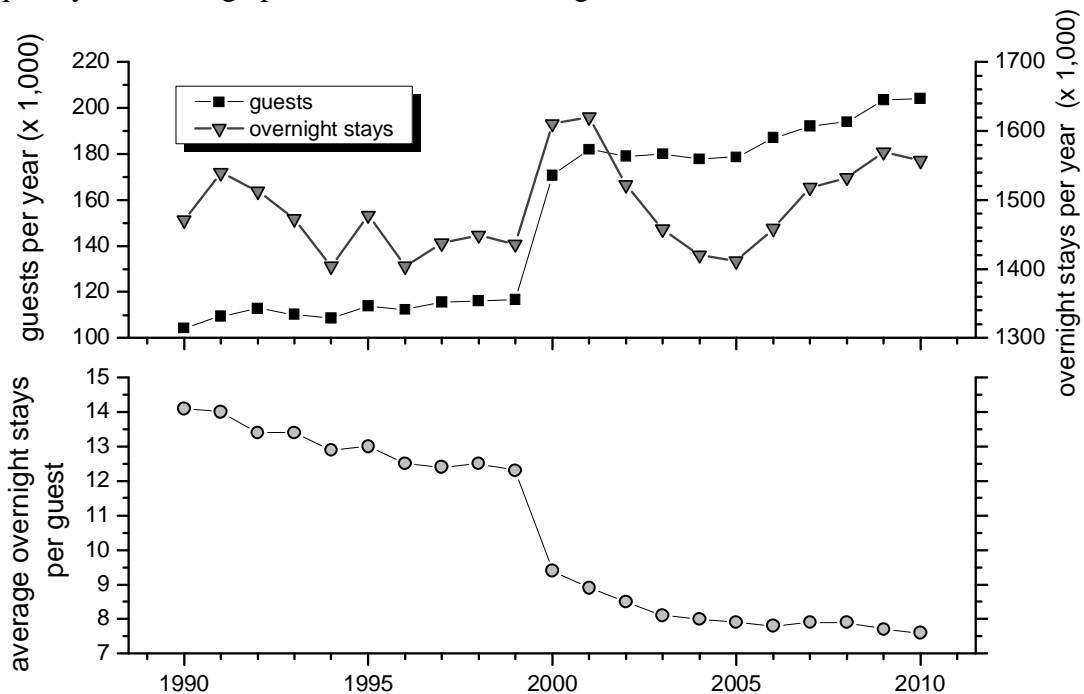


Figure 4. Development of tourism on Langeoog 1990 to 2010. The conspicuous “jump” in the curve around the year 2000 is related to the introduction of a digital tourist card, which replaced a previous analog tracking system (data: Langeoog municipality).

Individual vacation seasons, public holidays and weekends can easily be identified in the consumption curve (Fig. 5). The lowest water demand on Langeoog during the winter season of 2011 was 238 m³/d, while the maximum during the Easter holidays was 1,894 m³/d, a factor of eight between maximum and minimum! The highest demand in summer corresponds to the season of lowest or no groundwater recharge. The smaller neighboring island of Spiekeroog shows the same pattern (Fig. 5).

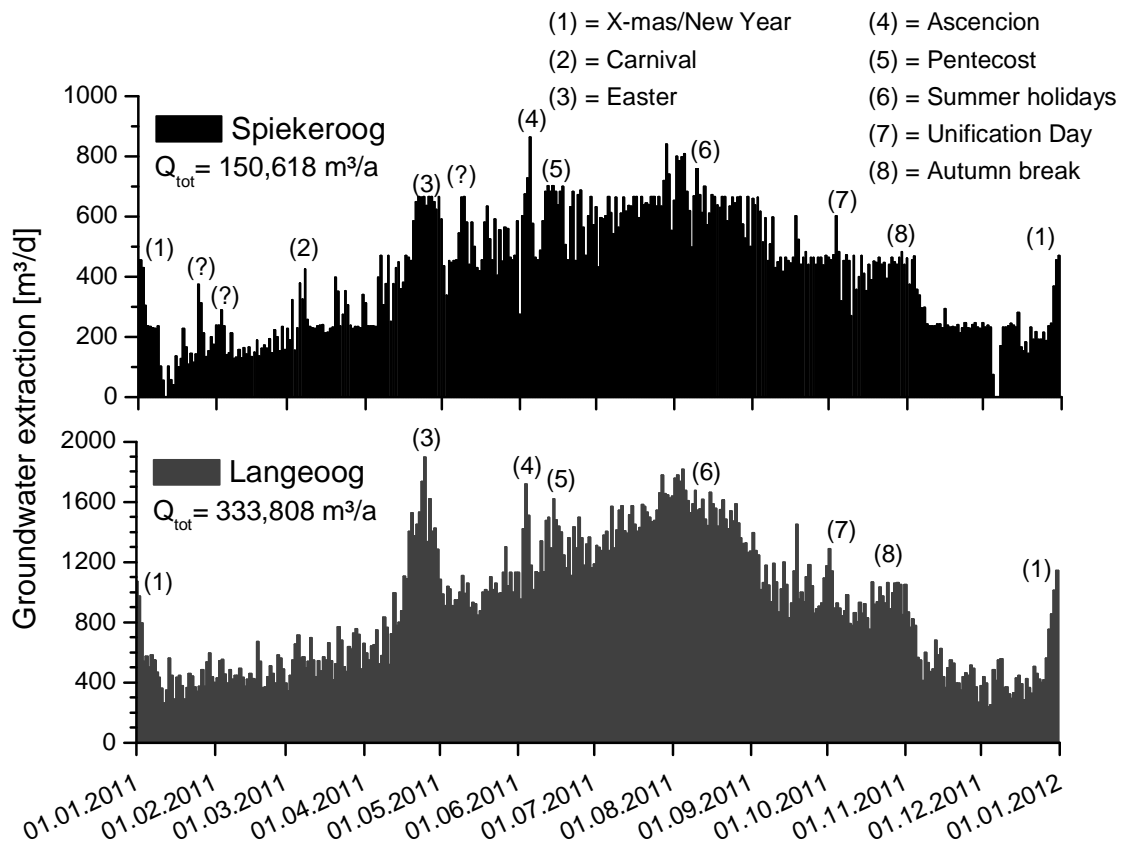


Figure 5. Groundwater extraction in 2011 on the islands of Spiekeroog and Langeoog (data provided by the water supply company OOWV).

DISCUSSION AND CONCLUSIONS

The temporal development of water consumption on the island of Langeoog closely reflects the history of tourism, both on the decadal and annual scale. The increase of tourism in the decades following World War II is mirrored by an increase in water demand. Overnight stays reached a plateau around the early 1990s but water demand decreased due to the implementation of water saving schemes. The impact of the latter effect seems to level off in the last years, so that water demand will probably reach a plateau at the current level of consumption. Groundwater levels show that the extraction is sustainable.

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