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Hygienic sustainability of site location of wastewater treatment plants A case study. I. Estimating odour emission impact

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ABSTRACT

By reference to the wastewater treatment plant of Taranto (Apulia Region, S. Italy), a typical Mediterranean city, an odour impact assessment has been carried out in order to evaluate the annoyance for the population living in the neighbourhood. In adverse weather conditions ("worst scenario"), the study indicated a limited off-site odour impact at the 300 m setback distance dictated by local regulation.

1. Introduction

Wastewater treatment plants (WWTP) can be the source of objectionable odours, particularly where anoxic and/or poorly aerated conditions exist both in the liquid and the sludge treatment sections and when meteorology is unfavourable (i.e., high humidity and temperature with moderate or extremely stable atmospheric classes). These conditions may yield the formation of odorigeneous compounds (e.g., ammonia and aliphatic amines, sulphidric acid, mercaptanes and in/organic sulphides, aldheydes and ketons, organic acids etc.) which may have a serious impact whenever an adequate distance cannot (or can no longer) be ensured to the neighbourhood as occurring in densely populated countries [1].

Unpleasant odours from WWTP may cause acute social and economic conflicts due to the deterioration of life quality and the economic depreciation of the neighbouring real estate, although they are normally unsusceptible of chronic health effects on nearby residents [2].

Several studies have concluded that complainants living near sewage plants and/or waste sites exhibit a greater number of odour-associated symptoms such as nausea, headache, lack of appetite and, more rarely, other acute and even chronic health effects, suggesting a direct relationship between odour and symptomatology [3–7].

In such situation the question of hygienic sustainability of site location of already existing or new WWTPs needs to be better addressed.

This is the case of Taranto (Apulia Region, S. Italy), a typical Mediterranean city whose WWTP, erected in the 1970s in the Gennarini area, today is surrounded by a densely urbanized district. Although local regulation [8] has tripled the 100 m setback distance dictated by national guideline [9], occasional smell from the plant, accompanied by nausea, diarrhea and other unpleasant effects among nearby residents, is causing heavy social conflicts and lawsuits against the Municipality with the request of transferring the WWTP in a new, more distant, site.

Accordingly, an odour impact assessment, together with the evaluation of potential airborne health hazard reported in Part II of this study [10], has been carried out in order to try to quantify the annoyance of the population living in the neighbourhood of Gennarini WWTP in Taranto, and to eventually assess the suitability of local setback distance. As ongoing civil and penal lawsuits against the WWTP inhibited the present authors from direct access into and measurements around the plant site, the study had to be largely based on model assumptions and

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the conclusions achieved need to be sustained by future direct investigation.

2. Materials and methods

2.1. Plant description

Gennarini WWTP, built in the 1970s for treating approx. 50,000 $m^3\,d^{-1}$ municipal sewage from the 150,000 inhabitants of Taranto city (Apulia, S. Italy), occupies about 125,000 m^2 in a flat, now densely urbanized area (see Figs. 1 and 2). The wastewater is continuously fed through the main collection sewer and added with concentrated sewage from isolated houses discharged discontinuously (from 8 to 10 a.m. usually) by tanker lorries (TD). The feed is screened by 3 moving screens (MS) that retain large solid material. The main pumping station, made by 2 Archimedean screws (AS) and 2 submersible pumps, conveys wastewater in parallel to 2 vertical-flow grit chambers (GC), where the separated grit is removed by a mammoth pump to a special trailer and hauled to a sanitary landfill. Wastewater then reaches 4 circular primary settlers (SI/1–4), assisted by chemical flocculation when necessary, from where it flows by gravity to 3 parallel rectangular aeration tanks (OX/1–3) to undergo biological treatment by the activated sludge process. Here bio-oxidation and bio-nitrification occur simultaneously through the mechanical aeration provided by 39 surface turbines aimed also at mixing the liquid. The mixed liquor flows to 4 circular secondary settlers (SII/1–4) and the overflow reaches the disinfection section (DS), where NaOCl is added in a contact serpentine reactor. After careful controls, the treated wastewater is finally discharged into the sea through an 800 m off-shore marine outfall.

A given amount of the sludge settled in the funnels ("biological sludge") is recycled while the excess is conveyed to the primary settlers. From these the mixed sludge is pumped to 2 primary thickeners (TI/1–2), then to 2 anaerobic digesters in series (AD/1–2) and finally to a secondary thickener (TII), reaching ≥6% w/w. The thickened sludge passes on to 2 horizontal belt presses (BP) for mechanical dewatering assisted by hydrated lime conditioning. During the warm season (April to October), sludge dewatering is usually carried out by the existing sludge drying beds (DB). The resulting semi-solid mixture (≤20% w/w) is finally pumped onto trails and hauled to a nearby plant for co-composting with source-sorted municipal solid waste.

Table 1 lists the technical characteristics of the main sections of the WWTP while Table 2 reports the average composition of the sewage before and after the treatment.

2.2. Odour assessment

It is generally acknowledged that for effective smell control odorigenous problems must first be quantified, but unfortunately odours are difficult to measure as individual response is highly subjective while odorous emissions from WWTP consist of complex mixtures whose overall odour cannot be predicted easily [11–14]. For these reasons a universally accepted method for odour measurement and quantification does not exist [15].

The most common method to determine odorants concentration is the *dynamic threshold olfactometry*, where a sample is progressively diluted until its odour is still detectable by ≥50% of a panel group [16]. The dilution number at the threshold concentration (Z) is called "odorant concentration" (C_{od}) and is expressed as "odour unit per

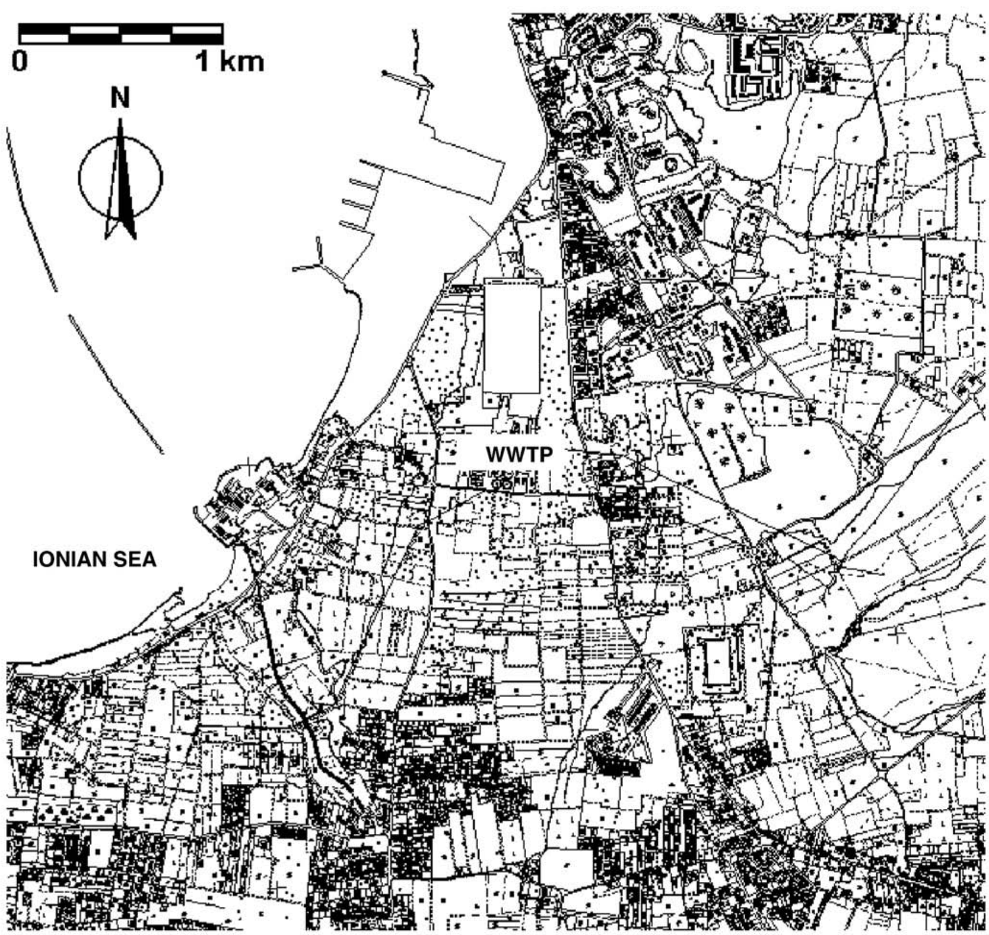

Fig. 1. Site location of Gennarini WWTP (Taranto, Apulia, S. Italy).