MODELS

Included here in WORD because in the pdf file, the models were not converted properly; this is from point 6.1 onwards in the papers)

6.1 Population and employment Sector

The main chain in this sector describes the transition of the population in Puerto Aura through different age groups and working status, Figure 14. During their working age, people can be grouped as out of the active economic population (AEP), as part of the employed and unemployed, or in retirement. At any time, the **employment rate (indicator 1)** can be estimated. Also, population can vary according to net migration in the area.The main feedbacks that come to the population and employment sector from other sectors are centered on the attractiveness to migrate to the zone as influenced by:

- Economic: business openings.
- Air pollution: pollutants and greenhouse gas emissions.
- Housing; availability of empty houses.
- Education and health; services capacities

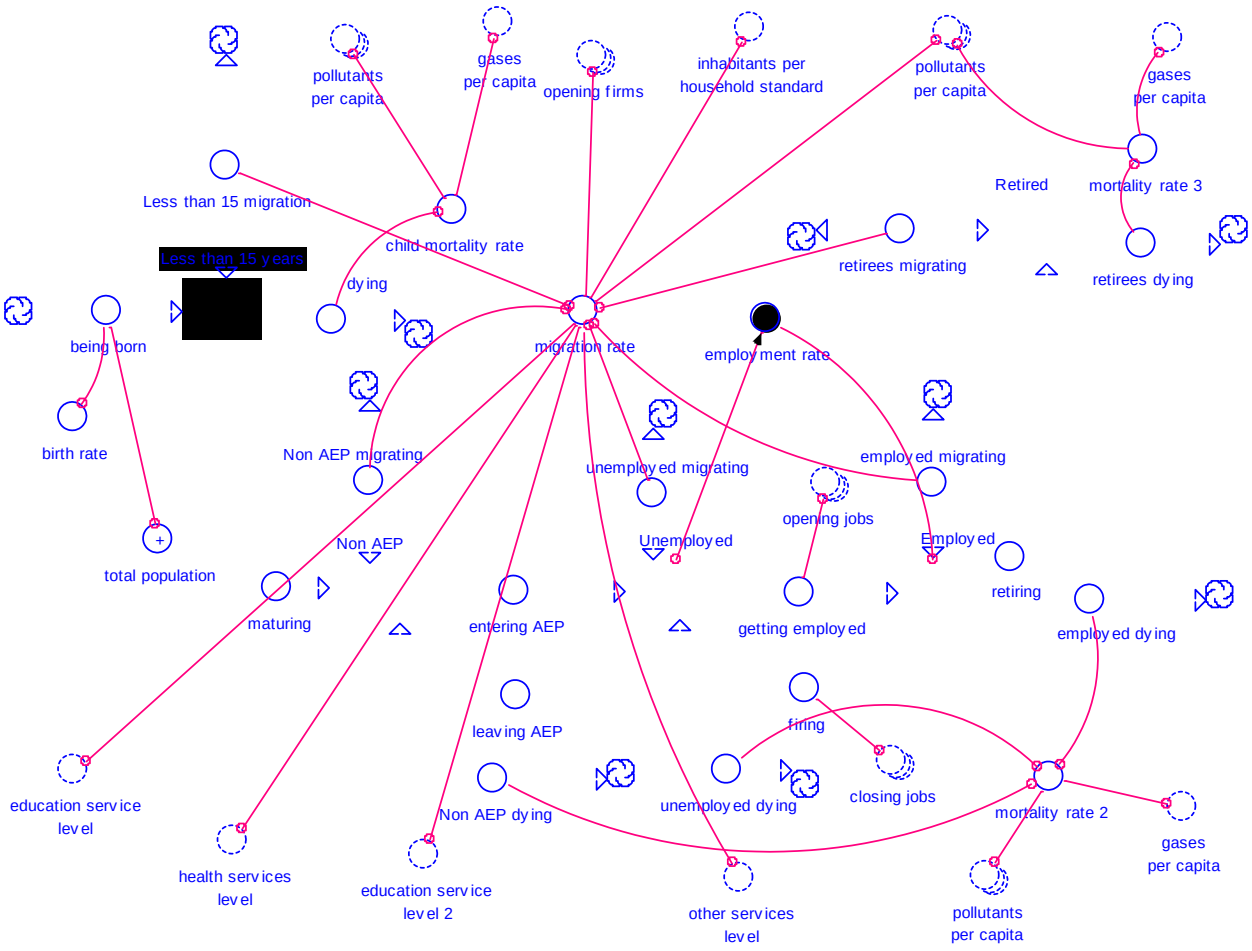

Figure 14. Population and employment sector, Source: Duran-Encalada and Paucar-Caceres

6.2 Housing sector

This sector is composed by housing in construction, occupied and empty (Figure 15). The demand for housing comes from the population in the zone and the living standards defined by policy. The model considers three main types of housing, high, medium and popular. Throughout the simulation the model indicates the average **number of inhabitants per household (indicator 2).**

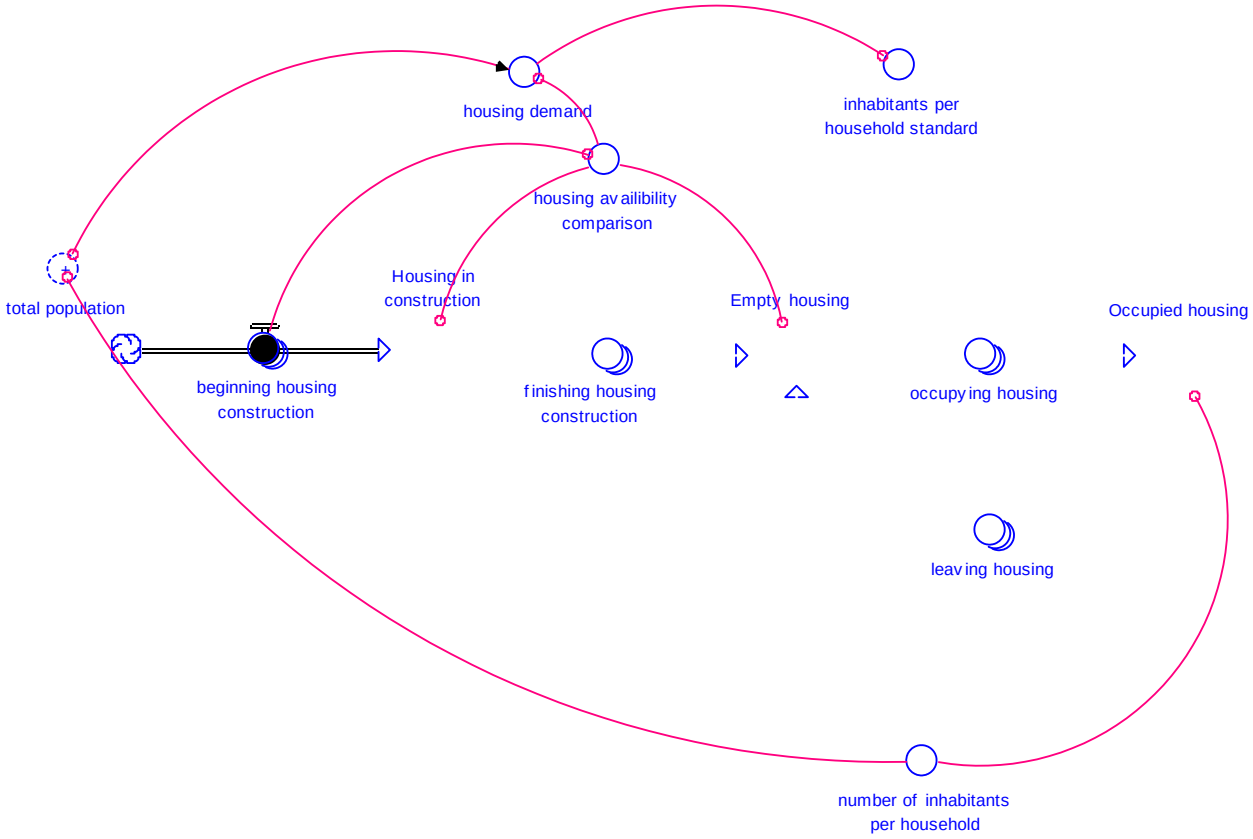

Figure 15. Housing sector, Source: Duran-Encalada and Paucar-Caceres

6.3 Education and health sector

This sector takes account of the demand made by the population for education services at different levels: pre-primary, primary, secondary, higher medium (technical and high school), and higher education (undergraduate and graduate) (Figure 16). A comparison is made between levels of demand and existing service capacities, and where demand exceeds the supply level a decision to increase capacity is taken, beginning by school construction activities. In a similar vein, the sector includes the health service and other public services demanded by the local population (lighting, security, among others). As a result of the sector dynamism the following indicators are obtained: **education service level (at different educational levels), health service level and other services level (indicators 3, 4 y 5).**

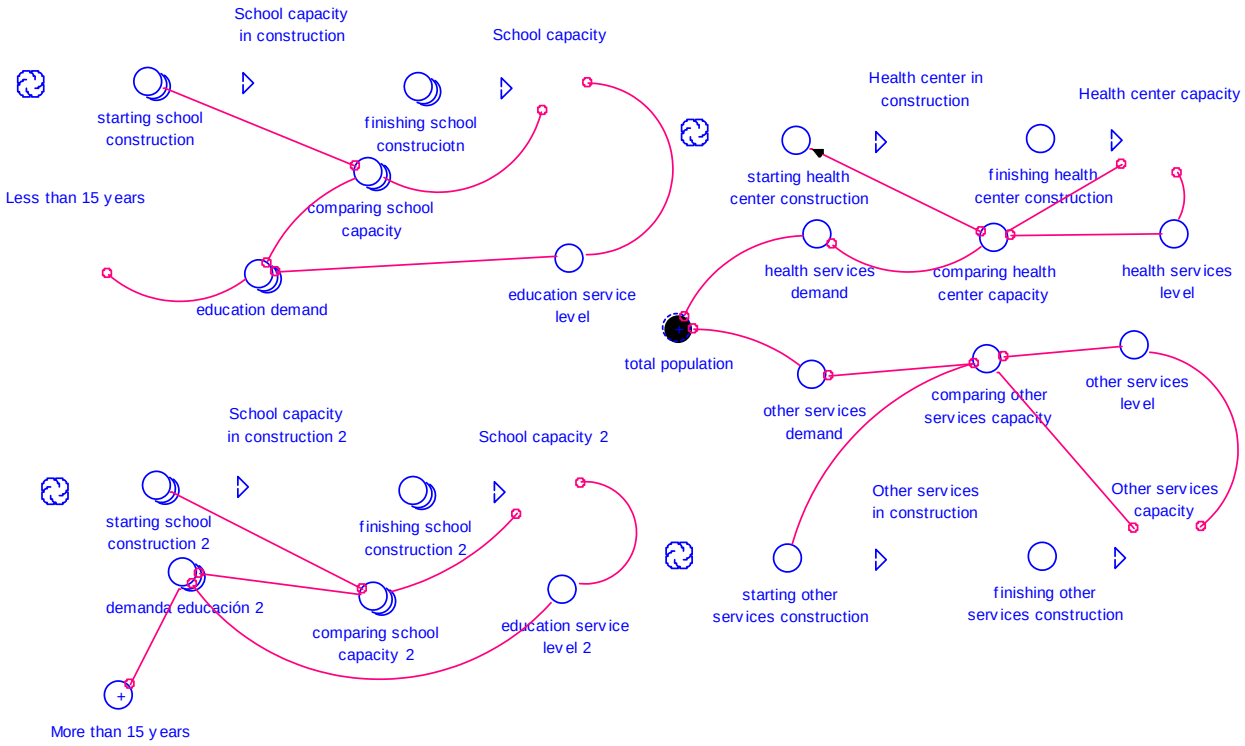

Figure 16. Education and health sector, Source: Duran-Encalada and Paucar-Caceres

6.4 Economic sector

In this sector new business openings and closings are registered, as well as the number of jobs created or made redundant, respectively (Figure17). Firms are classified according to different types of economic activities that have been planned for Puerto Aura: environmental managed units (EMU's), corporative offices, government services, hotel, sports, public services, thematic parks and commerce. Dynamism in the sector is the result of two main variables, the GDP growth rate and the attraction of visitor to the zone. The attractiveness for visiting the different amenities in the zone is affected negatively by the accumulation of solid waste, air pollution and traffic congestion in the area. Also, the occupancy of buildings by firms is monitored in this sector, triggering new building construction whenever needed. The indicator that comes from this sector is **business dynamism (indicator 6)**

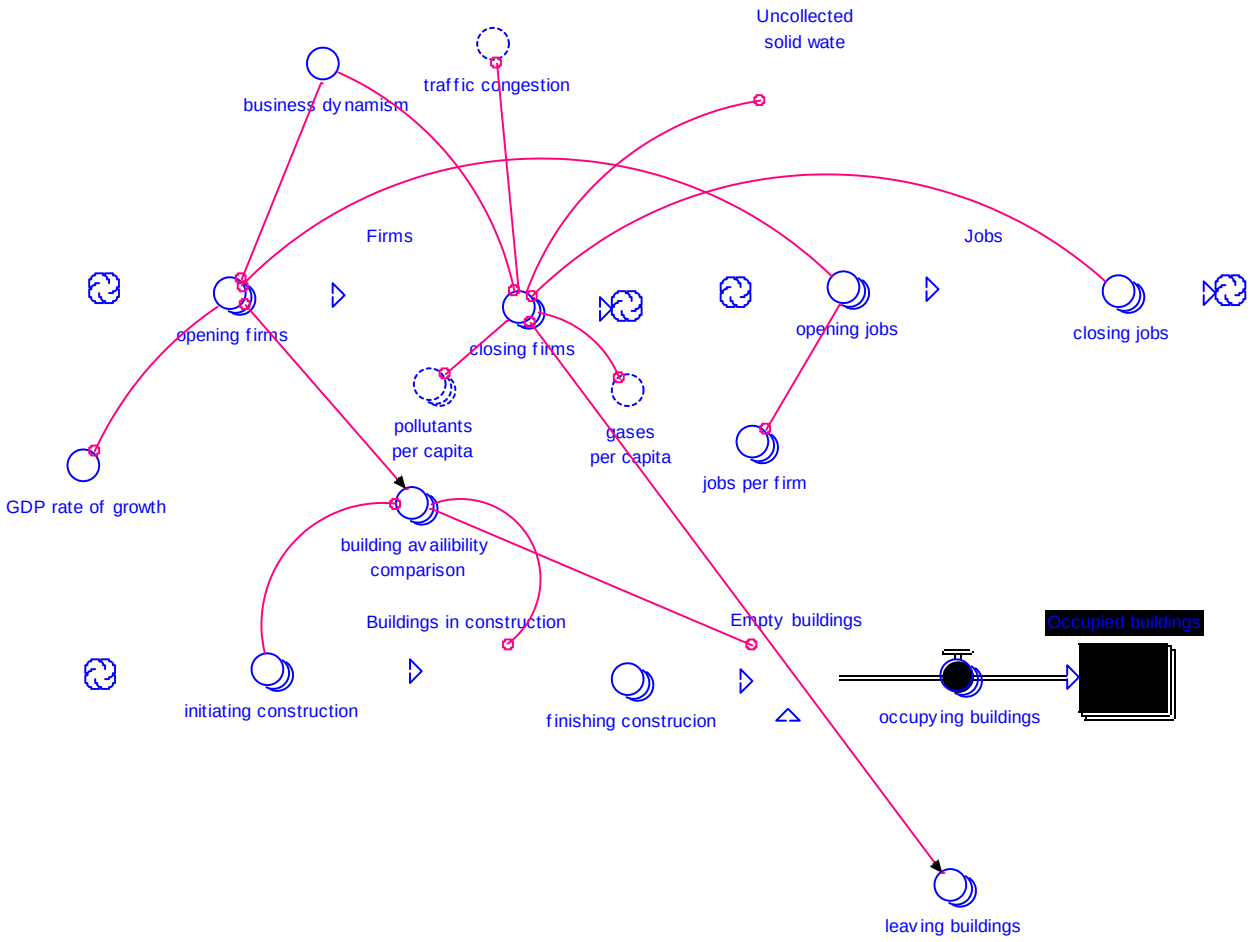

Figure 17. Economic sector, Source: Duran-Encalada and Paucar-Caceres

6.5 Transport sector

This sector includes the existing automobile stock which is determined by the population and public transportation facilities in the zone (Figure 18). The existing road network and those under construction are considered in this sector too. Four types of commuting patterns are identified in the zone: to work and to commercial areas for the local population, to amenities by visitors, and to work by non-local people, mainly those coming from the city of Puebla. The commuting, road capacity and vehicle stock are used to estimate **traffic congestion (indicator 7) and noise level (indicator 8)** in the zone.

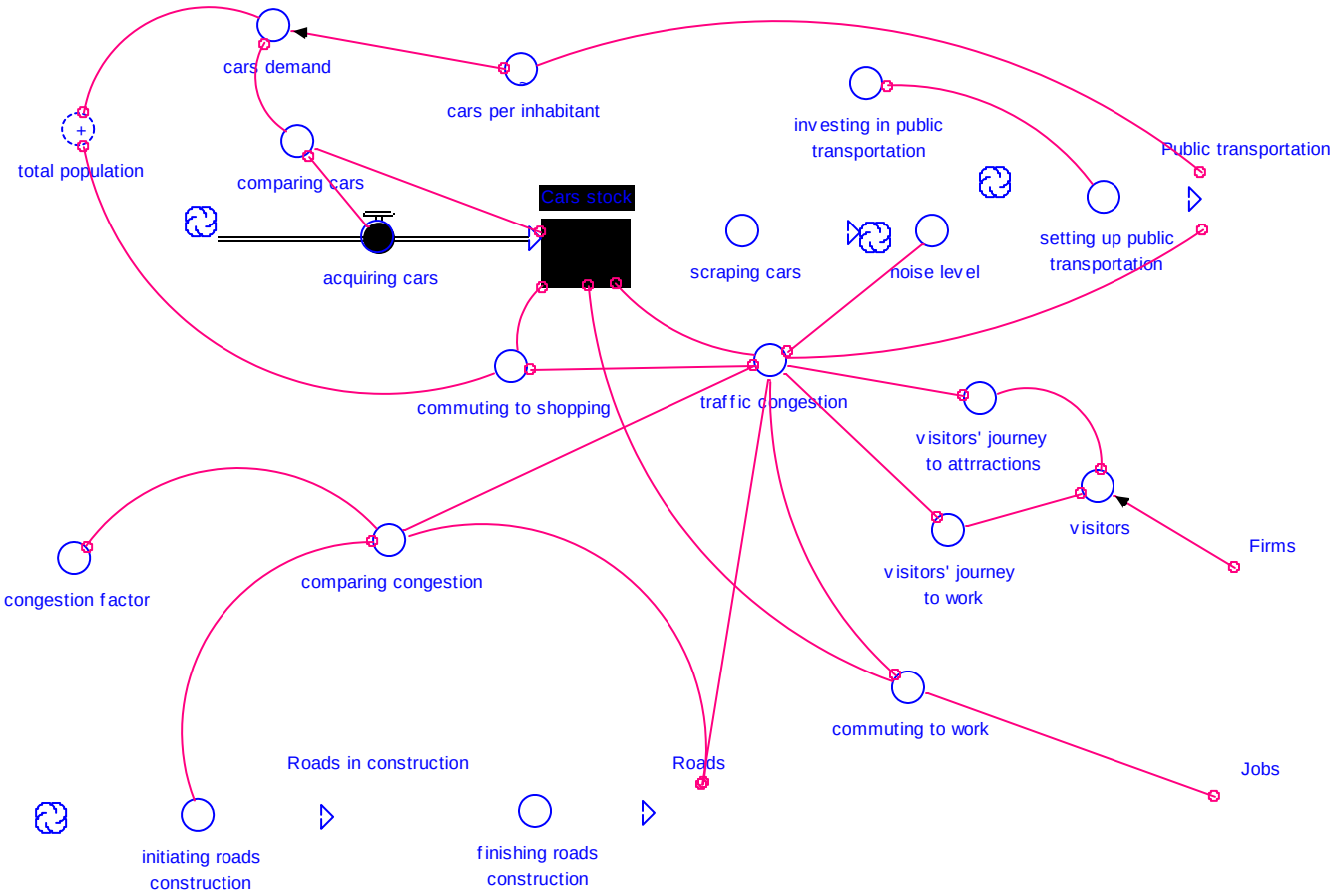

Figure 18. Transport sector, Source: Duran-Encalada and Paucar-Caceres

6.6 Water sector

The water consumption by residential, business, schools, health and medical centers, and other services provided in the zone is registered in this sector (Figure 19). If the water available becomes insufficient, some infiltration and well perforation works are carried on in order to provide more water to the region. However, infiltration capacity is reduced by the covered urban floor space in the zone. Consumed water is partially recovered by the water treatment plants and is brought back to the system for consumption. The indicator chosen in this sector was the **available water per house (indicator 9).**

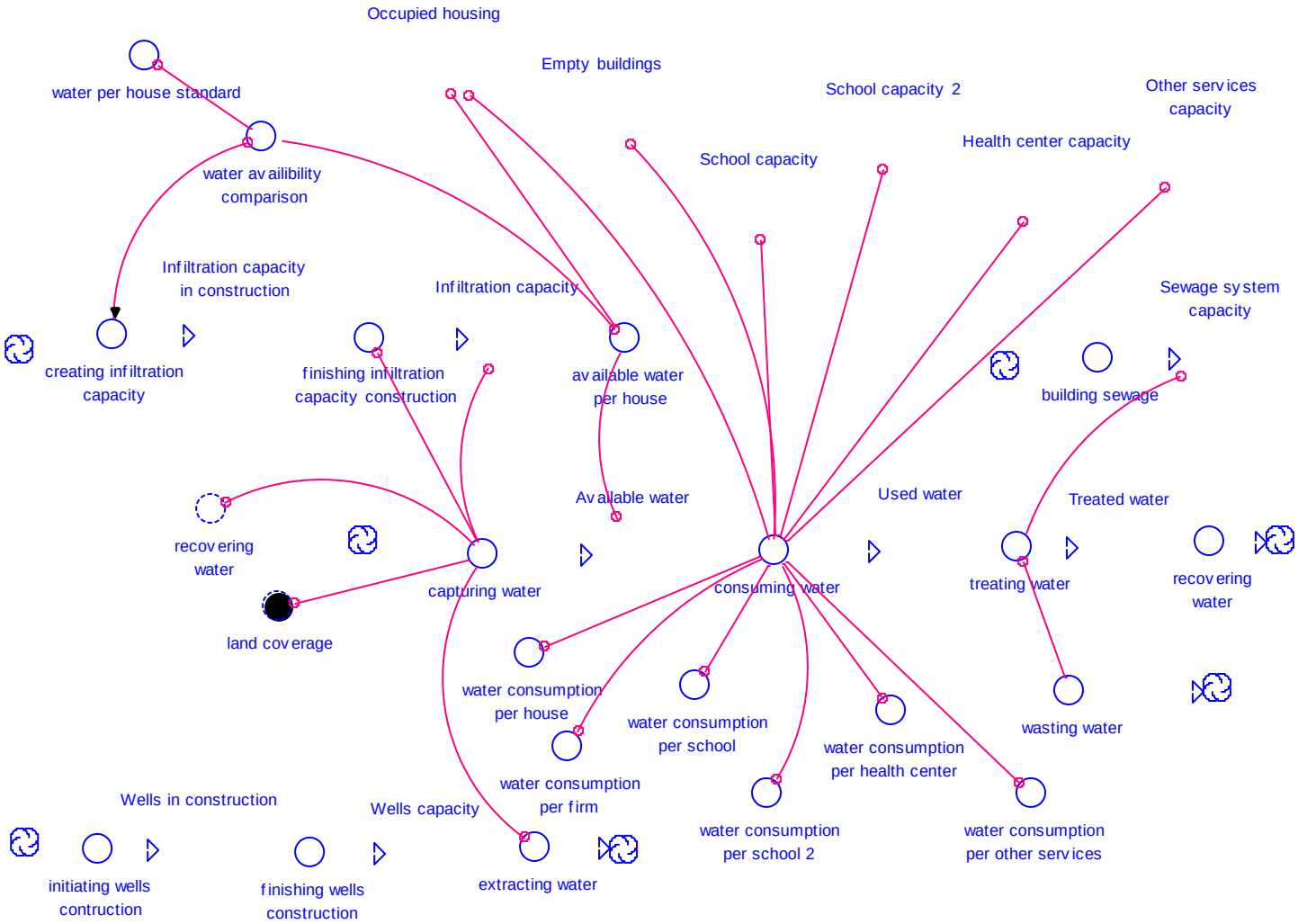

Figure 19. Water sector, Source: Duran-Encalada and Paucar-Caceres

6.7 Air pollution sector

Air pollution is the result of the vehicle stock, traffic congestion and commuting in the zone (Figure 20). Two types of contaminants are produced and registered, primary pollutants (SOx, NOx, and HC), and greenhouse gas emissions (GGE). From these and the total population in the zone, two indicators are obtained in this sector, **pollutants per capita (indicator 10) and gas per capita (indicator 11).**

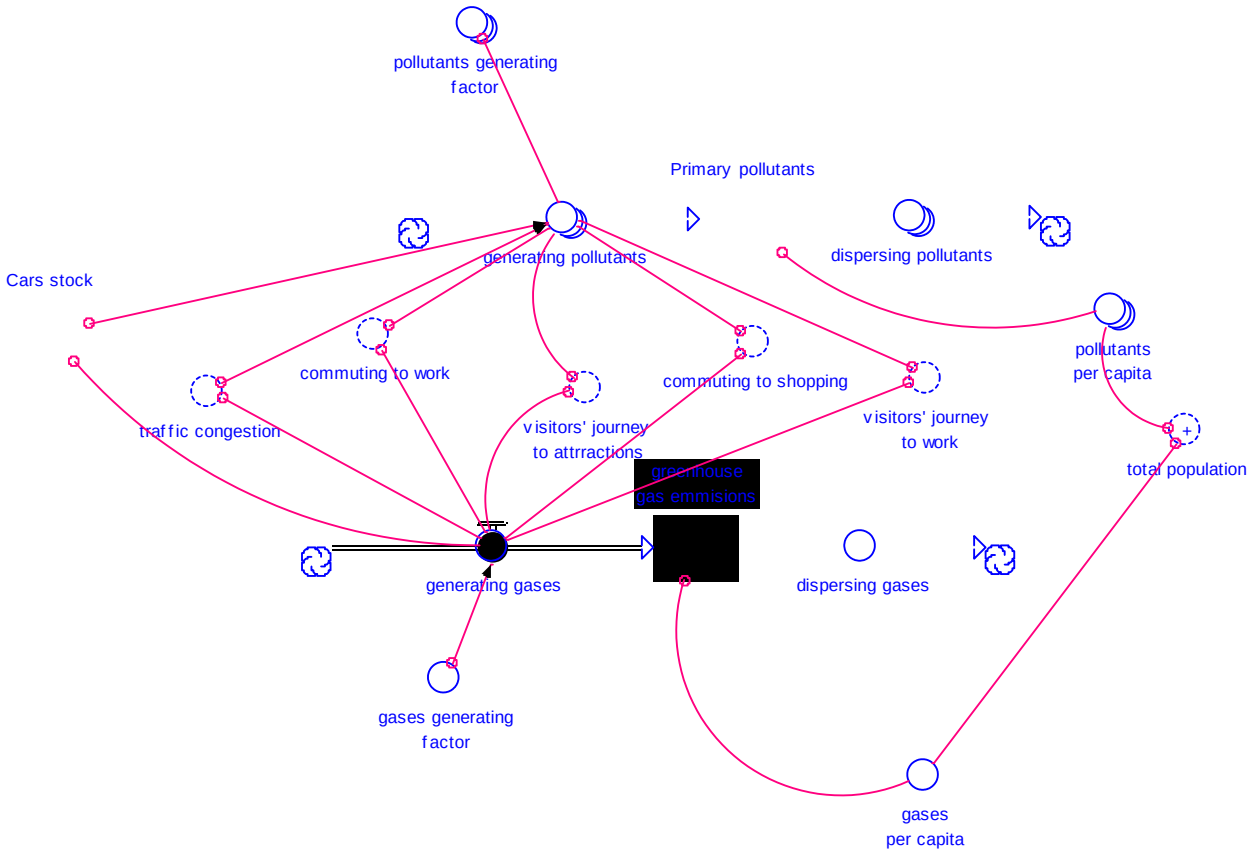

Figure 20. Air pollution sector, Source: Duran-Encalada and Paucar-Caceres

6.8 Solid waste sector

This sector shows the solid waste produced by households, business, schools, health and medical centers, and other services activities (Figure 21). This waste can end in two different places. First, it can be collected and then taken to public deposits where some portion is recycled. Second, waste could be accumulated in derelict land and streets without control. The clandestine organic and non-organic waste is dispersed in longer periods by natural biological and chemical processes. The **clandestine solid waste per capita (indicator 12)** is obtained in this sector.

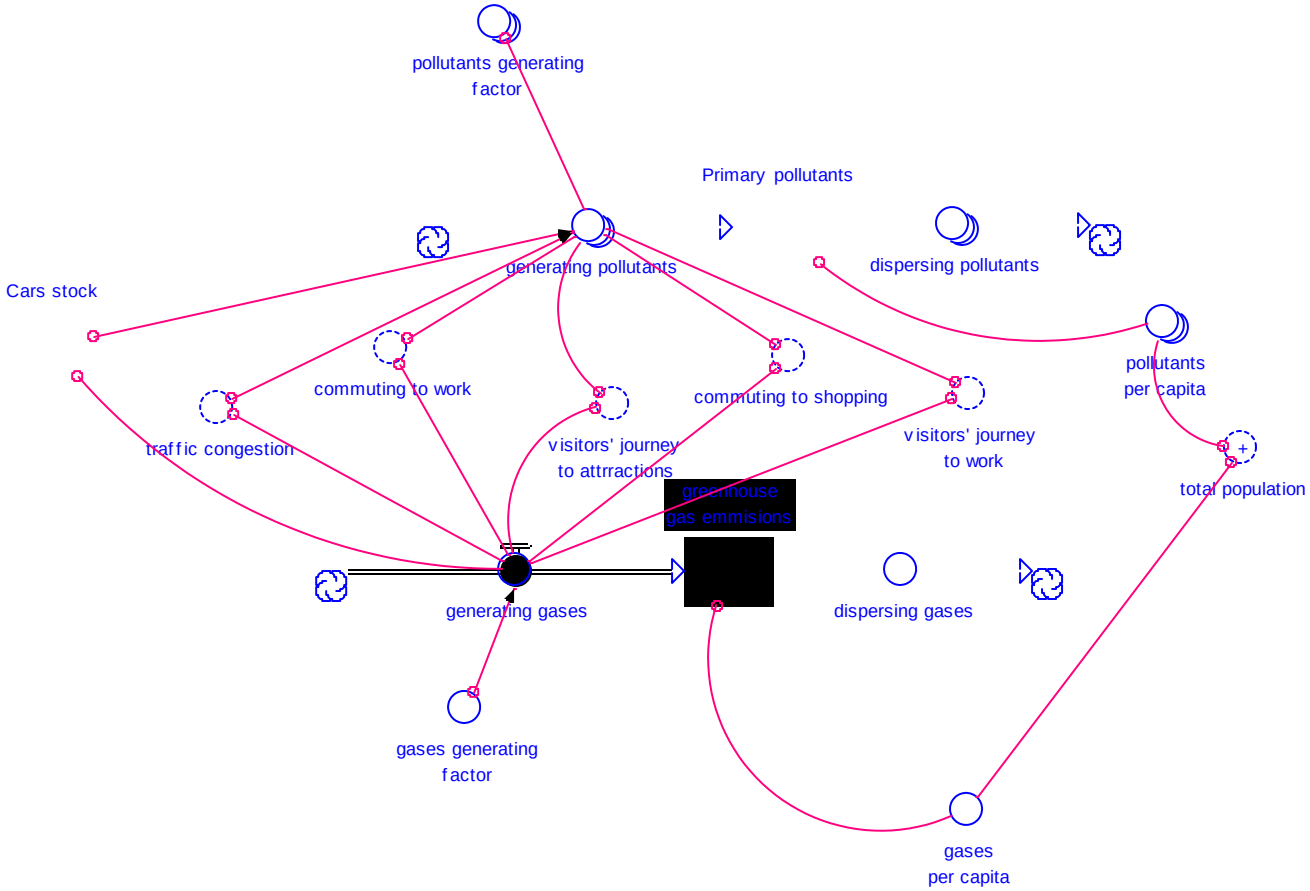

Figure 21. Solid waste sector, Source: Duran-Encalada and Paucar-Caceres

6.9 Land sector

The land sector shows that land which has been used for urbanization, as housing, commercial buildings, roads, and other urban facilities (Figure 22). When land is allocated to urbanization, the green areas diminish as indicated by the **land coverage (indicator 13).**

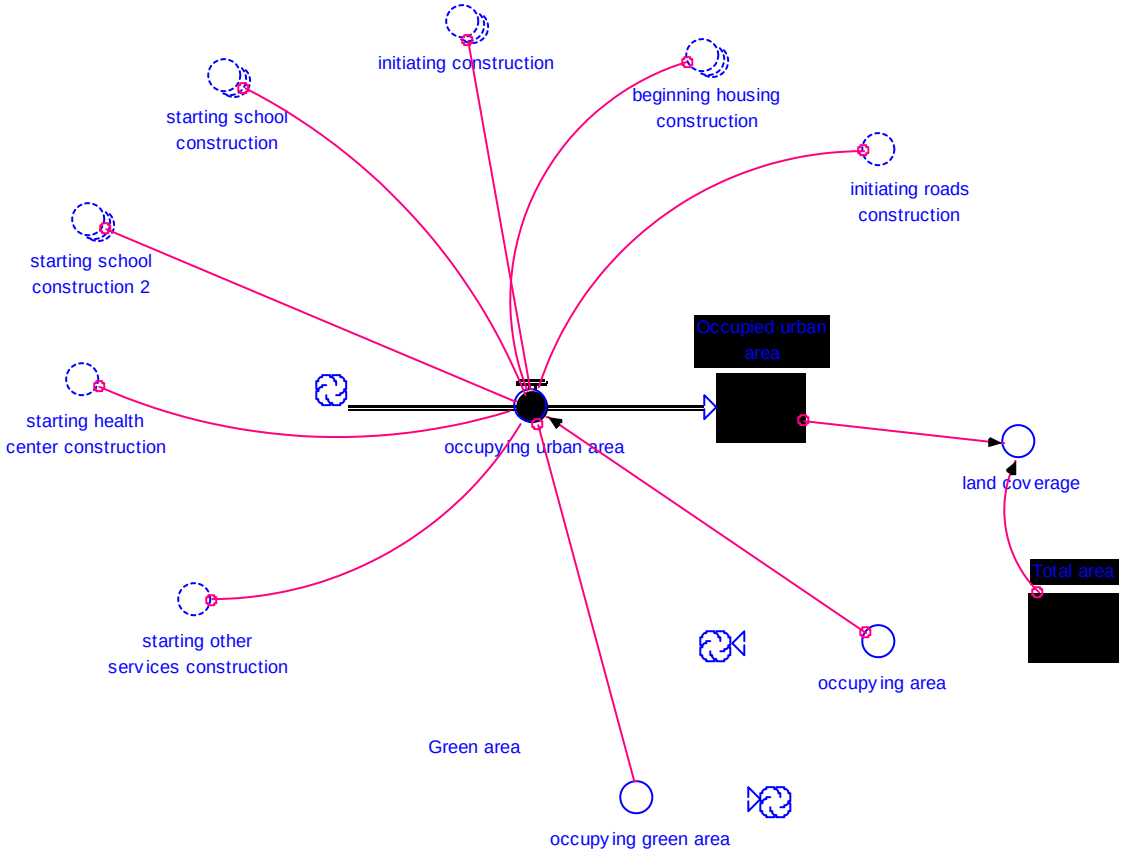

Figure 22. Land sector, source: Duran-Encalada and Paucar-Caceres