

Clays for Sustainable Urbanization

(Proposer: Dr. Luca Valentini)

As the World population is approaching 8 billion people (<https://www.census.gov/popclock/world>), two of the most urgent societal and technological challenges to be addressed are demographic growth and urbanization. Urban sprawl has a strong impact on the Anthropocene dynamics, as soil is consumed and landscape is modified by quarrying of raw materials and construction activities. Moreover, the production of building materials such as Portland cement contributes to a large share of the total anthropogenic CO₂ emissions, due to limestone decarbonation ($\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$) occurring during the production process. On the other hand, construction materials represent a fundamental resource for our society, since availability of a decent house is a basic human right, considering that about one billion people are still living in slums.

This project will face the challenge of providing low-CO₂ and low-cost building materials for a transition to a sustainable model of urbanization. Calcined clays are excellent candidates for playing a fundamental role in the future construction industry due to large worldwide availability, moderate cost and small environmental footprint upon thermal treatment. The PhD candidate will select and characterize suitable clay soils by laboratory techniques including XRD, XRF and thermal analysis. The selected clays will then be used to design and produce alkali-activated binders, one class of sustainable materials alternative to Portland cement. Specific tests will be carried out in order to reconcile small-scale properties, assessed by lab measurements such as SEM and X-ray tomography, and macroscopic material properties such as mechanical strength, dimensional stability and durability. The relationship between micro and macro will be explored by means of thermodynamic and kinetic models.

Possible collaborations will be carried out with academic institutions located in Kenya (Meru University of Science and Technology) and Ghana (Council for Scientific and Industrial Research).

