

EARTH SCIENCES AND ENGINEERING TECHNIQUES FOR THE DEVELOPMENT OF SOUTHERN ITALY – VINCENZO COTECCHIA'S METHODOLOGICAL APPROACH

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EXTENDED ABSTRACT

Il presente articolo è tratto dall'intervento tenuto dalla prof.ssa Federica Cotecchia in occasione della Giornata di Studio organizzata dalla Sezione Italiana dell'International Association of Engineering Geology (IAEG) in memoria del Professor Vincenzo Cotecchia, eminente figura della Geologia Applicata e della Geotecnica sia a livello nazionale che internazionale. Pertanto, non si configura come un articolo scientifico in senso stretto, bensì come una personale, intima e al contempo profonda e ampia riflessione sulla trasversalità culturale e sull'impegno civile che hanno caratterizzato l'intera esistenza di Vincenzo Cotecchia, focalizzandosi sul fecondo "coniugio" tra le Scienze della Terra e l'Ingegneria. Questa interconnessione, da lui vissuta come un'etica della conoscenza volta alla salvaguardia delle comunità e allo sviluppo della società, trova il suo terreno d'elezione nel Mezzogiorno d'Italia, concepito come un immenso laboratorio a cielo aperto in un importante momento storico quale il secondo dopoguerra.

Il percorso formativo di Vincenzo Cotecchia affonda le radici nella Napoli a cavallo della seconda guerra mondiale e negli anni stimolanti della Facoltà di Ingegneria dell'Università Federico II, dove apprende le scienze di base da maestri del calibro di Renato Caccioppoli e sviluppa le competenze idrauliche e territoriali sotto la guida di Girolamo Ippolito, laureandosi nel 1948 con due tesi, una sui ponti e l'altra sul tema delle gallerie. Trasferitosi nel 1950 presso l'Università di Bari, dove opererà per oltre quarant'anni, Cotecchia diviene l'artefice della Scuola di Geologia Applicata e Geotecnica, ricoprendo ruoli istituzionali di primo piano come Preside della Facoltà di Ingegneria, promotore del Politecnico di Bari nel 1990 e suo primo Professore Emerito, oltre a contribuire alla nascita della Facoltà di Ingegneria dell'Università della Basilicata.

La sua impostazione metodologica rifiutava ogni forma di ipersemplificazione, estendendosi dalla scala regionale a quella di sito e dell'ammasso roccioso, fino al dettaglio della microstruttura dei terreni. In questo contesto, promuove l'utilizzo di metodologie d'avanguardia, quali i microscopi elettronici a scansione per le argille, le sonde nucleari e inclinometriche automatizzate, le indagini geofisiche applicate ai versanti e il monitoraggio satellitare tramite tecniche DInSAR. Sul piano istituzionale e della gestione delle emergenze territoriali, la sua attività ha marcato pietre miliari, partecipando dapprima alla Commissione Interministeriale De Marchi per la difesa del suolo e guidando poi il Sottoprogetto "Fenomeni Franosi" nell'ambito del Progetto Finalizzato del CNR Geodinamica, all'indomani della tragedia del Vajont e inoltre coordinando gli studi del post-terremoto dell'Irpinia del 1980, i cui risultati confluirono nel convegno internazionale della IAEG, tenutosi a Bari nel 1986.

Altrettanto fondamentale risulta il suo contributo all'idrogeologia, comparto nel quale avvia ricerche pionieristiche sulla vulnerabilità dell'acquiferi carsici pugliesi e sui fenomeni di intrusione marina, culminate nella fondazione di un laboratorio specialistico del Comitato Nazionale per l'Energia Nucleare a Bari e successivamente nella redazione di una monografia edita dall'ISPRA. La sintesi perfetta tra le intuizioni dell'ingegnere e la sensibilità del geologo si è tradotta nella progettazione di imponenti opere infrastrutturali nel Meridione, tra cui - per citarne solo alcune - la Diga del Locone, la Diga Pappadai, le opere di stabilizzazione delle frane di Lucera e Senise, la galleria idraulica Pavoncelli-bis e l'impianto di depurazione di Scafati. Tale approccio è stato applicato con successo anche a contesti urbani complessi, come nel caso del parcheggio sotterraneo in P.za Cesare Battisti a Bari, risolto mediante iniezioni impermeabilizzanti nei calcari carsificati, riprendendo un'intuizione metodologica già sperimentata negli anni Cinquanta per il risanamento della Cripta della Basilica di San Nicola, sempre a Bari.

Infine, nell'articolo viene evidenziato l'impegno profuso da Vincenzo Cotecchia nella tutela del patrimonio culturale e archeologico. Infatti, in qualità di membro della Commissione UNESCO, offre un contributo decisivo nel salvataggio dei templi egizi di Abu Simbel minacciati dalla diga di Assuan, dedicandosi successivamente alla protezione del sito di Sibari e della Valle dei Templi di Agrigento.

Il ritratto che emerge è quello di uno scienziato che ha saputo unire l'eccellenza accademica a una profonda umanità, animato da una incrollabile fiducia nel futuro, da spiccate doti di mediazione e da una straordinaria passione per il proprio lavoro. Questi tratti della sua forte personalità sono condensabili nella celebre massima "adda passà 'a nuttata, andiamo avanti", che ancora oggi risuona come un prezioso manifesto metodologico e morale per le future generazioni di ingegneri e di geologi.



Prof. Vincenzo Cotecchia 1925- 2019

KEYWORDS: *engineering geology, geotechnics, combined approach, infrastructure design, southern Italy, seismic areas, landslides, hydrogeology, cultural heritage*

Together with my sister, I would like to thank the Italian Group of the International Association of Engineering Geology (IAEG) for organising this event in memory of our father, Vincenzo Cotecchia, and for dedicating its PhD award for the best thesis in Earth Sciences to him.

When Professor Lollino invited me to give this presentation, I felt somewhat daunted by the scope of the topic that I was asked to address: “Earth Sciences and Engineering Techniques for the development of Southern Italy - Vincenzo Cotecchia’s methodological approach”. Needless to say, it is a very complex topic, dealing with the convergence of two worlds: Earth Sciences and Engineering. These two disciplines are necessarily interconnected in both ensuring the safety of communities and supporting the development of society. In my father, this convergence was driven by a deep love for geology and by an engineer’s creative ingenuity; it could be achieved only by fostering the cross-disciplinary interplay between these two worlds - a hallmark of Vincenzo Cotecchia’s scientific and professional work. Moreover, the title included a reference to “Southern Italy” (Mezzogiorno), the region to which he

devoted himself in a particularly significant way throughout his scientific, academic, and professional life.

However, my embarrassment also arose from another question - “why me?” - perhaps because, as his daughter, I shared part of that intellectual development shaped by the dialogue between Engineering and Earth Sciences, and I was, in a sense, also his disciple (Fig. 1). In fact, there were many disciples of Vincenzo Cotecchia - his scientific and professional



Fig. 1 - Vincenzo Cotecchia together with his daughter Federica

“offspring” - who could certainly address this topic far better than I can, having worked alongside him for many years in both scientific and professional activities, and knowing episodes and

this topic, the intent was to invite a different narrative: that of someone who experienced it from behind the scenes and came to understand its ethical implications and its human story. Indeed,



Fig. 2 - Vincenzo Cotecchia with his team

anecdotes that I do not, since my father greatly enjoyed his time working with his collaborators (Fig. 2 and 3).

I therefore started thinking that, by asking me to address



Fig. 3 - Vincenzo Cotecchia with collaborators of him

Vincenzo Cotecchia inspired in those who were by his side a deep emotional engagement with these land-use and environmental issues, and he treated the union between Earth Sciences and Engineering as an “ethic” of knowledge - a guiding force in responding to the problems of civil society. For him, this union was more a way of life than anything else. This is why I will not deal with this topic from a strictly technical - scientific viewpoint, but will instead outline a few aspects of how he experienced this “ethic”, an ethic that permeated his private sphere and that I present to you here because I believed, and still believe, in this demanding, painstaking, yet richly rewarding methodological legacy.

Under his methodological approach, the solution to any territorial issue required not only the contribution of human and social sciences (society lives in spatial contexts), but also a scientific dialogue drawing on the diverse expertise across the multiple disciplines dealing with soil, subsoil, and engineering.

I have attempted to draw up a thematic map - perhaps somewhat simplistically - of this interdisciplinary dialogue, trying to enter into the core of that “union” through which Vincenzo Cotecchia always tackled any spatial issue requiring an engineering solution. He did so by starting from knowledge of the soil - subsoil system, rooted in basic sciences and Earth Sciences, for every aspect within their merit: from physics and

mathematics to chemistry, mineralogy, petrography, stratigraphy, geomorphology, and so on. From these disciplines, through site and laboratory investigations, he characterised the factors and processes active within the system, also including the engineering intervention, which had to be integrated into the geological model of the subsoil. This model, however, was expected to respond to the engineering problem, becoming a tool to predict the evolutionary dynamics of the area serviceability affected by the engineering intervention.

Hence, the system should be characterised hydrogeologically and mechanically, using the synthetic schematisations of the engineering method. Such characterisation would support the predictive analysis of the system's response to the engineering project, making it possible to test the modelling, safety, and sustainability of the project in accordance with the fundamental laws governing the system.

Given this convergence between geology, engineering geology and geotechnics, the project should not be the end point of the relevant activities, but rather the starting point guiding the investigations of reality and leading to the development of an overall model. Such a model would map the complex physical reality (the area and the intervention) so as to make it manageable from an engineering standpoint. This has always been the guiding vision of the School of Engineering Geology and Geotechnics of Bari.

Thus, based on this vision and with a consistently deterministic approach, Vincenzo Cotecchia adopted an approach that spanned multiple scales. At the broadest level, he worked at the crustal and rock mass scales - hence his dialogue with experts in tectonics and structural geology - in order to contextualise the project or problem at a regional level. He then moved to the site scale, and finally to the detailed scale, where he densely populated the area under study with numerous points of characterisation and measurement of physical, mechanical, and hydraulic properties. The project sites thus became true open air laboratories. This process ultimately enabled the characterisation of materials at the representative element volume scale, an approach that, over time, led to the establishment of several geotechnical laboratories.

Vincenzo Cotecchia and his school conducted pioneering studies on the microstructures of clays, examined with the first scanning electron microscopes, and on the influence of microstructure on the mechanical properties of clays.

Vincenzo Cotecchia always sought to innovate in investigation methods, e.g. through the use of nuclear probes to measure the density and natural water content in the subsoil, automated inclinometer probes, geophysical surveys to explore seepage processes in slopes, and the groundbreaking application of satellite based displacement monitoring with DInSAR techniques. He thus maintained a consistently kaleidoscopic view of the processes governing the system affected by the project,

adopting a multiscale approach marked by uncompromising rigour. Indeed, he did not tolerate any attempts to introduce unwarranted simplifications: for him, detail always had to be consistent with synthesis.

Today, the cross-disciplinary interplay required by this cultural process demands the integration of different skills and areas of specialisation, all rooted in a single context, namely the site or, more broadly, the area to be investigated with the comprehensive vision outlined so far.

The roots of this multidisciplinary approach, spanning from engineering geology to geotechnics, lie in Vincenzo Cotecchia's personal, educational, and professional background.

He was born in Naples in 1925, and he spent his childhood under fascism and his adolescence during the war, years in which he nonetheless displayed remarkable intellectual liveliness and a deep curiosity for natural sciences, shared with life-long friends.

In 1943, the year of the liberation of Naples, he enrolled in the School of Engineering at the "Federico II" University of Naples, where he completed a two year programme in basic sciences, taught by eminent scholars, such as Renato Caccioppoli. Within the intellectually rich environment of the School of Engineering, he focused on Earth sciences and hydraulic engineering, under the guidance of his mentor Girolamo Ippolito, professor of Hydraulic Constructions, and other professors of transportation and structural engineering. This ultimately led him to graduate with two theses: one on bridges and the other on railway tunnels.

During this period, he acquired the broad-ranging knowledge of a well-rounded civil engineer, graduating as such in 1948, and already adopting the method of geology applied to engineering together with his friends Felice Ippolito and Arrigo Croce - within a school that was progressively specialising in geotechnical engineering - and with Elio Giangreco, a colleague in structural engineering. In 1950 he moved to the University of Bari, where he would spend the next about 50 years of his career.

It is in this historical context that civil engineering began to open itself to environmental protection and to the development of entire areas of the country, still wild and inhospitable, such as those of inner areas of southern Italy, where both basic science and engineering science were called upon to support the new challenges of land-use management and development.

His central focus was the *questione meridionale* - in the 1950s, Southern Italy was still economically backward and isolated, with pressing development needs - an issue that deeply engaged Vincenzo Cotecchia and which he explored extensively in his studies. The South was the open air laboratory in which he could apply his vision and develop engineering interventions capable of responding to primary needs, such as water supply and land stability (Figg. 4, 5 and 6).

At the University of Bari, Vincenzo Cotecchia held the chair of Engineering Geology and Geotechnics, served as Vice Rector,



Fig. 4 - Vincenzo Cotecchia while doing field survey in the countryside (Basilicata, 1950s)



Fig. 5 - Vincenzo Cotecchia at desk writing notes (1950s)



Fig. 6 - Vincenzo Cotecchia in the field testing a water-well (1960s)

and was Dean of the School of Engineering from 1972 to 1981. He also founded the Institute of Engineering Geology and Geotechnics together with numerous distinguished colleagues. In the late 1980s, he played an active role in the establishment of the Polytechnic University of Bari, founded in 1990, and became its first Professor Emeritus in 2001.

During the 1980s, he was also a member of the Founding Committee of the School of Engineering of the University of Basilicata, where he became the first Dean.

The collective experiences that most profoundly shaped Vincenzo Cotecchia, allowing him to express his vision, were: the Interministerial De Marchi Commission (1966-1970) for the study of hydraulic and soil protection projects; the targeted research project Conservazione del Suolo (soil conservation), launched in the aftermath of the Vajont landslide disaster, within which he led the sub project on Landslide Phenomena; and the extensive study and management activities following the 1980 Irpinia earthquake. Together with his “School”, he conducted wide ranging studies on the multiscale effects of the earthquake, whose significant results were presented at the IAEG International Symposium on Engineering Geology Problems in Seismic Areas, which he organised in Bari in 1986.

Another important branch of his scientific work was hydrogeology. He carried out pioneering studies for the characterisation of the Apulian karst aquifer, where groundwater overlies intruding seawater. In this regard, he worked towards the creation of a laboratory of the Comitato Nazionale per l'Energia Nucleare (CNEN, National Nuclear Energy Committee) in Bari, specialising in the application of radioisotopes to hydrogeology, which attracted numerous researchers and technical experts from Northern Italy (Fig. 7). As early as in the 1980s, the results of the hydrogeological research conducted by the Bari School were being presented at various Salt Water Intrusion Meetings (SWIMs), one of which was held in Bari in 1983.



Fig. 7 - The plate of the CNEN Laboratory for the application of radioisotopes to hydrogeology (1960s)

At the end of his career, Vincenzo Cotecchia summarised the findings of his decades-old research in this field into a monograph entitled “Le acque sotterranee e l'intrusione marina in Puglia”: dalla

ricerca all'emergenza nella salvaguardia della risorsa", published by Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA, Italian Institute for Environmental Protection and Research).

Vincenzo Cotecchia had engineering in his DNA: a drive towards synthesis in order to identify an engineering solution firmly anchored in the geological substrate, combined with a passion for the project to which he devoted himself with ingenuity, imagination, and creativity. The list of engineering projects in which he was involved as engineering geologist and geotechnical engineer is massive, including design of dams (Fig. 8), tunnels, foundations, slope stabilization measures (Fig. 9), waste-water treatment systems, excavations ecc.. Among the projects planned after the 1980 earthquake, he contributed to the construction of the major road infrastructure along the Sele river valley, and to the design and construction of the Pavoncelli bis hydraulic tunnel, a project to which he dedicated himself with particular commitment following the damage sustained by the original tunnel during the 1980 Irpinia earthquake.



Fig. 8 - Aerial view of the Locone dam during construction (1970s)



Fig. 9 - Landslide remediation works in Lucera (1980s)

Among his more recent projects, it is worth mentioning the design of the underground car parks in the city of Bari, excavated within karstified limestone horizons. In particular, in the case of the car park in Piazza Cesare Battisti - which required a structure below the groundwater level - he specifically designed a hydraulic sealing system using cement grout injections into the karstified limestone hosting the aquifer. This strategy mirrored the approach that he had already employed in the 1950s to waterproof the perimeter of the crypt of the Basilica of St. Nicholas in Bari which, being flooded by groundwater, had remained inaccessible to the public for a long time.

The latter example bears witness to Vincenzo Cotecchia's passion for the protection of monuments and archaeological heritage.

As a member of the UNESCO Commission for the International Hydrological Decade (1966-1976), he took part in the work carried out for salvaging the Abu Simbel temples during the construction of the Aswan Dam in Egypt, whose reservoir would have submerged the temples. He was thus able to contribute to the strategic decision to dismantle and relocate the monuments - a trailblazing archaeological conservation project (Fig. 10).

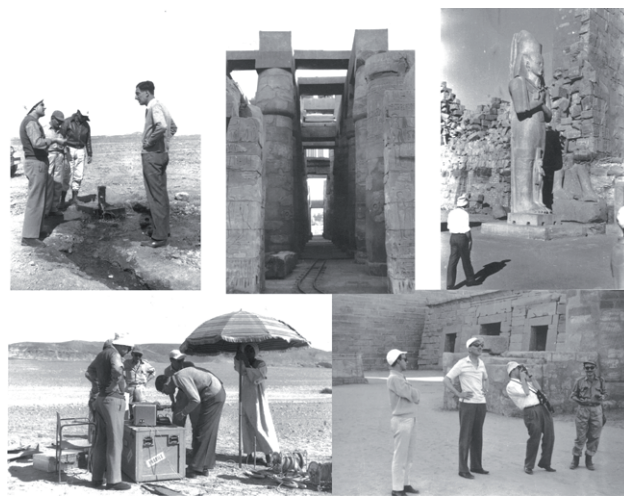


Fig. 10 - Images of Abu Simbel temples during the construction of the Aswan Dam (Egypt) (across 1960s and 1970s)

Finally, within the framework of the CNR strategic project Beni Culturali del Mezzogiorno (Cultural Heritage of Southern Italy), he carried out studies for the conservation of the archaeological site of Sibari. Later, he devoted considerable effort to ensuring the stability of the Valley of the Temples in Agrigento (Temple of Juno Lacinia), for which he also prepared the management plan.

In summary, Vincenzo Cotecchia loved life and took great joy in his work (Fig. 11); he radiated the confidence of a generation that had lived through the war, always looked to the future without forgetting the past, and he encouraged Patience and Mediation: "S'adda aspetta'/adda passa' a nuttata/andiamo avanti" (we must wait - the hard times will pass - let us carry on).



Fig. 11 - Vincenzo Cotecchia in front of a bridge (Basilicata)

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