

# **The Effect of Proximity to Fault Line as a Land Value Determinant in Metro Manila**

**Florence GALEON, Meneleo ALBANO, Philippines**

**Keywords:** Land Valuation, Fault Line, Earthquake Risk, Market Value, GoogleEarth

## **SUMMARY**

The geographic and geologic settings of the Philippines make it prone to earthquake-related and other hazards. Experts have studied numerous earthquake sources in and around Metro Manila, and among these faults, the West Valley Fault System is predicted to have the largest impact. The 90-kilometer fault runs from the Angat reservoir in the north through populated Metro Manila cities and ends in Calamba, Laguna. The implication of breaking this news is the possible decline in property values particularly those directly on top or very near the fault. The determination of the effect of proximity to fault line on the land values will provide an actual figure for real estate professionals. It gives also the opportunity to inform or educate stakeholders of the existence of faults and its potential risk while doing the fieldworks and interviews. The coordinate locations of market samples and the fault line are loaded in GoogleEarth for visual appreciation and analysis. The collected market data are subjected to “Grid Analysis” using a patterned array showing adjustments of differences in attributes and coming up with an opinion of value. The output is the land market value differences as a result of the varying distances to fault line. The validation fieldworks conducted in the middle of year 2014 generated some interesting but at the same time disturbing findings. Lot or property owners and other real estate participants have limited or no knowledge of the existence of the fault and the risk of the coming big earthquake. As a result, the proximity of the lands to the fault apparently has no effect on the land values in Metro Manila. The intensified efforts and awareness campaign of the government about the coming of a high magnitude earthquake nicknamed “Big One” has increased public perception about safety and hazard adaptation. Recent data clearly show the negative effect of the proximity to fault line in the land prices of Metro Manila. However, there is no enough market data to correlate decrease in land values to fault line proximity.

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## 1. INTRODUCTION

The real estate always plays a vital role in a country's economy. Knowing the factors affecting urban land value is an important advantage in identifying the future of urban development and anticipating potential changes. In the Philippines there are many spatial factors considered by professional appraisers which influence and affect land values. Galeon and Pornasoro (2012) has identified six of the most significant parameters of value which include land use type, neighborhood classification, accessibility to main roads, proximity to points of interest, easement condition and corner Influence. These factors are considered by most valuers for many years as the essential basis of urban land valuation although may vary from one appraiser to another. Today, after experiencing devastating floods in Metro Manila, another very important factor considered by property buyers is flood risk.

The Philippines ranks third worldwide with the largest disaster risk (WorldRiskIndex 2012). The geographic and geologic settings of the Philippines expose it to different natural hazards including earthquakes. Experts have studied numerous earthquake sources in and around Metro Manila, and among these faults, the West Valley Fault System is predicted to have the largest impact on Metro Manila should it generate a large earthquake. The Marikina Valley Fault System also known as the West Valley Fault System is the biggest fault line system in Metro Manila. The 90-kilometer fault runs from the Angat reservoir in Bulacan through Quezon City, Marikina, Pasig, Makati, Taguig, Muntinlupa, Rodriguez Rizal, Cavite and ends in Calamba, Laguna. The map of the West Valley Fault System is shown in Figure 1 below.

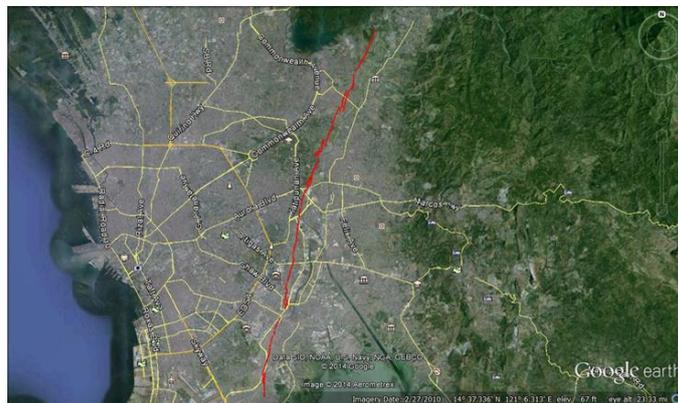


Figure 1. Map of the West Valley Fault System

According to PHIVOLCS, this fault line is already overdue for its “movement”. If this movement happens, it is predicted that the quake can reach up to magnitude 7.2 resulting to estimated 35,000 casualties, 120,000 injured and more than 3 million people needed to be evacuated. In a report published March 14, 2011 in a Daily Inquirer, catastrophic scenarios can be cited by 'Pacific Strategies' based on assessments if a high magnitude earthquake hit Manila. Estimated damage can be 117,000 homes that would collapse, 1.2-million homeless, damage purification plants and water reservoirs that would immediately cut off water supply to about 4,000 connected points, estimated 30-kilometers of electric cables will be cut off and removing the power supply instantly across the metropolis. Furthermore, the CNN in 2010 report said, "If earthquake of 7.2-magnitude hit Manila, it is expected to damage 38% of homes, public buildings, and cause around 50,000 plus of possible deaths.

The predictions present varying numbers but the same devastating outcome. This is bound to happen and there is nothing we can do really to prevent it. Our response under the imminent danger of this “act of God” is preparedness. A well-prepared citizenry may not save the whole city but it would mean everything to every person that would receive a helping hand on that day. Another thing which must constitute part of our response as Christians is prayer. All the government efforts and awareness campaign of the coming of a high magnitude earthquake nicknamed “Big One” has certainly increased public perception about safety and hazard adaptation. There is much implication of breaking this news to owners of the houses constructed on top or within 5 meters of either side of the fault including in particular property values.

## **2. LITERATURE REVIEW**

A fault, according to the United States Geological Survey (USGS), is a break in the rocks that make up the earth’s crust along which rocks on either side have moved past each other. Most faults are the result of repeated displacements over a long period of time. Energy release associated with rapid movement on active faults is the cause of most earthquakes. The surface trace of fault, the line of intersection between the fault plane and the Earth's surface, is a fault line.

A land parcel’s characteristics play a big role in its value. A piece of land or property located in an Earthquake Fault Zone must be disclosed to a potential buyer before the sales process is complete. The real estate agent or the owner/seller is legally bound to present this information to the buyer. This is usually done at the time an offer is made or accepted. In California, USA, the Natural Hazards Disclosure Act requires that sellers of real property and their agents provide prospective buyers with a "Natural Hazard Disclosure Statement" when the property being sold lies within one or more state-mapped hazard areas, including Earthquake Fault Zones. In a March 2012 article “It's unlivable: QC, Phivolcs study renews warnings over West Valley Fault”, Elmo San Diego, action officer of the Quezon City disaster risk reduction management council and head of the city’s department of public order and safety, was quoted as saying that the areas on top of the fault line are “unlivable”.

From an article “Suit claims homes built on fault lines”, Gordy Bunch of the USA is continuing his legal battle after learning in April 2011 that his \$1.2 million home was built on a fault line costing

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thousands of dollars in repairs. He filed a lawsuit against the real estate companies for allegedly not disclosing the fact that the lot, and then the home, was located on the Big Barn Fault line. The fault issue has dramatically affected the value of their home and property. According to the Montgomery Central Appraisal District, the 2010 value of the home and property was \$1.2 million which has dropped to \$200,000 in 2013. From another article “What Influences Land Value?”, a 2011 study from the University of California-Berkeley found that lot values dropped as much as 2 percent for every mile closer the lot was to a fault line. Gu et al., (2012) showed the effect of earthquake risk in land values. The price of nonresidential land one kilometer off the Uemachi fault line was 1,000,000 yen per m<sup>2</sup> in 1996, while the price of nonresidential land with similar characteristics, but immediately above the fault, was only about 700,000 yen per m<sup>2</sup>, a discount of 300,000 yen per m<sup>2</sup>.

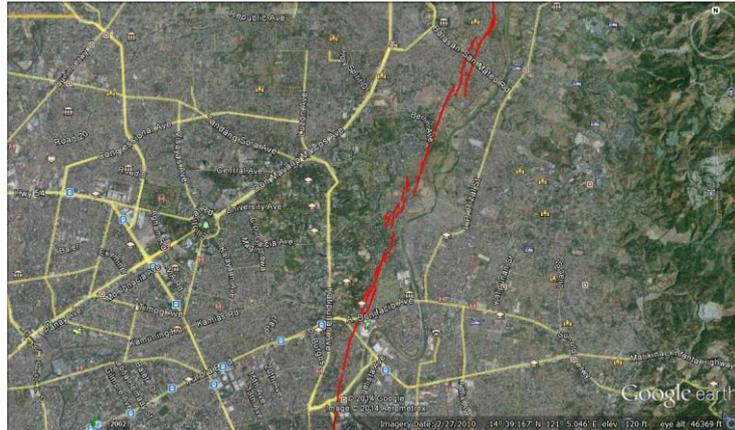
### **3. OBJECTIVES AND SIGNIFICANCE OF THE STUDY**

Price theory predicts that buyers will attempt to discount property prices for earthquake risk if they are aware of it or worse they reject it outright. Home owners are not alone in their concerns about the value of their property. Professional appraisers and mortgage lenders need to know about the value of property at risk to advise their clients and protect their investments.

This study will determine the effect of a relatively new environmental factor in land valuation, earthquake risk, on the land values in Metro Manila. It attempts to provide a value indication of the actual losses of land values at different distances from the West Valley Fault System. The determination of the effect of proximity to fault line on the land values will provide an actual figure for appraisers and mortgage lenders for their professional work as real estate advisers. It gives also the opportunity to inform or educate owners and other people of the existence of fault line and its potential risk while doing the fieldworks and interviews.

### **4. STUDY AREA**

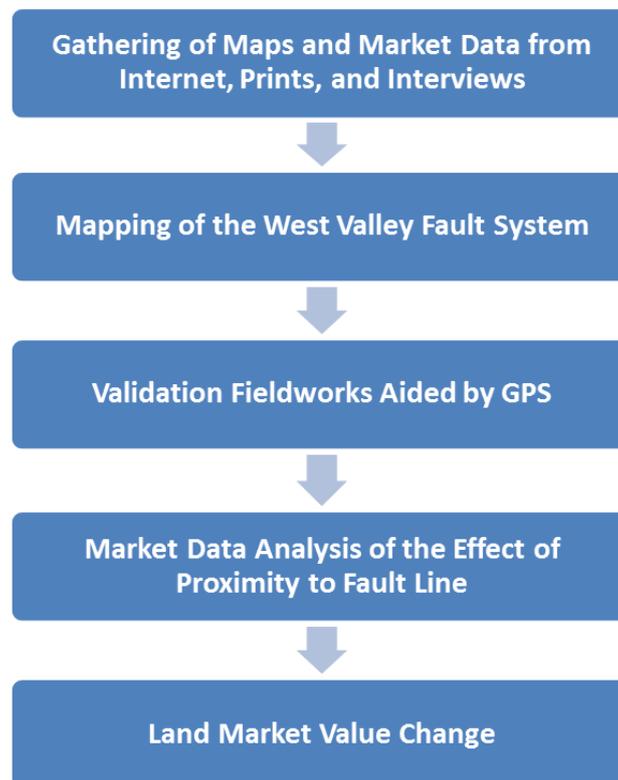
The study area is the northern portion of the West Valley Fault System covering heavily affected areas in Quezon City and Marikina City. Included are barangays of Batasan Hills, Commonwealth, Bagong Silangan, Holy Spirit, and Matandang Balara in Quezon City predicted to be most imperiled by the expected earthquake scenario according to an independent study by Earthquake and Megacities Initiative (EMI) commissioned by the Quezon City Government. In Marikina City the barangays of Barangka and Industrial Valley Complex are expected to get hit hard by the quake. The affected areas are densely populated surrounded by schools, shopping malls, industrial zones, and transport hubs. The map of the study area and its extent is plotted in GoogleEarth and presented in Figure 2 below.



**Figure 2. Map of the Study Area**

## 5. METHODOLOGY

There are five (5) general steps needed to accomplish this study and is illustrated in Figure 3 below.



**Figure 3. Methodology Flow Diagram**

The first major work for this study is data collection. The first important information needed to determine the effect of proximity to fault line in land valuation is to know where the fault line is

located. The authority to be consulted on this subject matter is the Philippine Institute of Volcanology and Seismology (PHIVOLCS). According to its website, PHIVOLCS is a service institute of the Department of Science and Technology (DOST) that is principally mandated to mitigate disasters that may arise from volcanic eruptions, earthquakes, tsunami and other related geotectonic phenomena. In the absence of proprietary property databases used by more matured countries performing land valuations, the next best source available is the internet. Websites of buy-and-sell online companies such as OLX.ph - Philippines' #1 Buy and Sell provided a number of offered properties for sale. Print ads like Buy and Sell magazine, Manila Bulletin and The Philippine Star newspapers added more to the scarce market data. All these data gathered are actually verified through telephone interviews and personal inquiries.

The digital data obtained from PHIVOLCS is mapped in GoogleEarth to have a visual appreciation of the location and extent of the West Valley Fault System. Google Earth, according to Wikipedia, is a virtual globe, map and geographical information program that maps the Earth by the superimposition of images obtained from satellite imagery, aerial photography and geographic information system (GIS) 3D globe. Printed images and online applications using Android phones guided the fieldworks in traversing the fault line. Barangay Halls along the way are visited and interviews with authorities are conducted. Market values from the internet and prints are validated in the field and available land data are collected as well. Location coordinates of subject lots are observed using a handheld Global Positioning System (GPS) receiver.

After data collection and validation the next major step is to do the market data analysis correlating land values and proximity of these lands to fault line. The location coordinates of market samples and the fault line location are loaded in GoogleEarth for visual appreciation and analysis. The collected market data are subjected to "Grid Analysis". Grid analysis as applied in valuation is comparing a subject property to a comparable property using a patterned array showing adjustments of differences in attributes and coming up with an opinion of value. The supposed output is the land market value differences as a result of the varying distances to fault line.

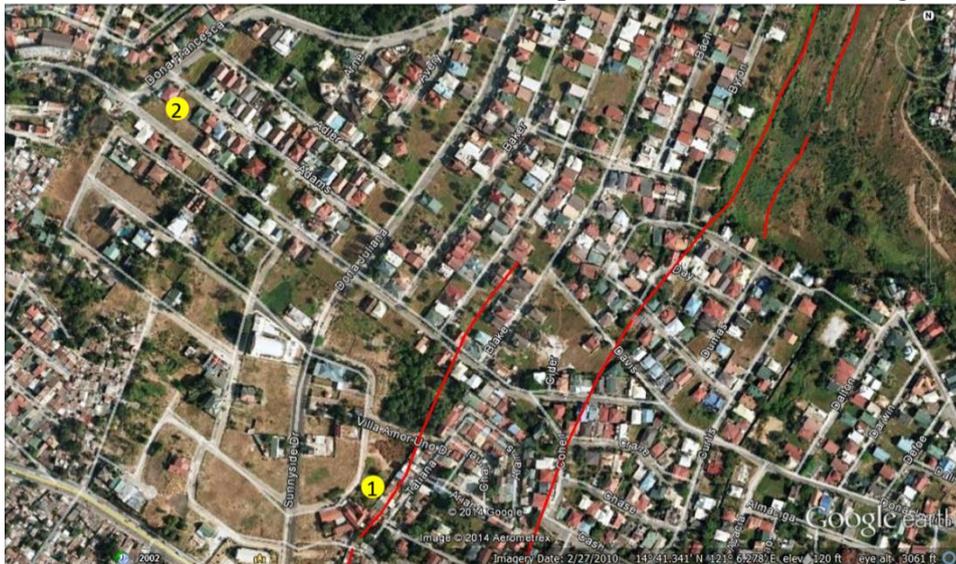
## **6. RESULTS AND DISCUSSIONS**

Reliable market data is difficult to find. There is sporadic availability of market offerings in the media and real estate players but is rare to find a market transaction that has been actually consummated. Market offerings are usually the available data for a subject lot which, initially, is much higher than the desirable price for a buyer. Market Value is the estimated amount for which a property should exchange on the date of valuation between a willing buyer and a willing seller in an arm's length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently, and without compulsion (International Valuation Standards).

To extract a realistic price from the market, the price has to be negotiated with the seller. Two strategies can be employed. First, the researcher may honestly inform the seller about the actual objective of the study or secondly, pretend to be a serious buyer. The former technique can get the researcher fortunate to be granted full cooperation but also risk the possibility of getting the seller disinterested in the conversation. The latter strategy proved to be more effective in bringing down

the price and extract the representative market value of the subject lot. A thorough interview of the owner or his representative must be conducted and the figures generated are subjected to Grid Analysis.

This study was first conducted in the middle of 2014. Initial results of the market data gathering is examined and filtered to come up with a few comparable lots for analysis. Other market data are discarded because of many differences in characteristic which may lead to inaccurate conclusion. The chosen lots must have practically the same land attributes to isolate the effect of their distances from the fault line. The lots are compared to each other based on these characteristics: price, area, location, time of sale, property rights, access, utilities, topography, zoning, traffic, frontage, shape, elevation, and distance to fault line. The first set of comparable lots is shown in Figure 4.



**Figure 4. Map of Comparable Lots in Sunnyside Heights Subdivision**

The two comparable lots are located inside the Sunnyside Heights Subdivision in the northeastern part of Quezon City. These two selected lots have slight differences in frontage and area but basically share the same characteristics except the last two namely elevation and distance to fault line. These measurements are derived from interviews and the use of GoogleEarth. The summary of the comparisons between these two lots is shown in Table 1.

**Table 1. Grid Analysis of Sunnyside Heights Subdivision Lots**

List of Comparable Characteristics	Comparable 1	Comparable 2
Price/sqm	PhP 8,000	PhP 8,500
Area (sqm)	450	400
Location	Sunnyside Drive	Dona Justina St.
Time of Sale	Recent	Recent
Property Rights	Fee Simple	Fee Simple
Access	Main Road	Main Road
Utilities	All	All
Topography	Road Level	Road Level
Zoning	Residential	Residential
Traffic	Moderate	Moderate
Frontage (m)	18	15
Shape	Rectangular	Rectangular
Elevation	129 ft or 39 m	228 ft or 70 m
Distance to Fault	10 m	370 m

These two lots considering the mentioned attributes are similar to each other but differing in distance to fault line with the first lot being only 10 meters near the fault while the other is some 370 meters away. Obviously the nearer lot to the fault has lower price than the other and this price difference apparently is attributed to their distance. However, the result of the interviews proved otherwise, as the proximity of these lots from the fault line are never considered in the land pricing. The truth is that there is lack of knowledge where the fault line is located and simply ignorance of its existence. The logical reason for the difference in land value is the difference in elevation. The latter is located in higher grounds and therefore less vulnerable to flooding. The former lot is near the fault line that actually serves as part of a drainage system making this lot vulnerable to flood.

The next set of comparable lots is from the Industrial Valley Complex in the southwestern portion of Marikina City. The four lots are shown in Figure 5.



**Figure 5. Map of Comparable Lots in Industrial Valley Complex**

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These selected lots also have slight differences in frontage, area, and access but basically share the same characteristics except elevation and distance to fault line. Lot 1 is the nearest to the fault while the other three are almost similarly distant. Surprisingly, Lot 1 commands the highest price among the four lots even though it is quite near the fault. This contradicts the assumption that being near the fault causes a decrease in the price of a piece of land. The obvious reason for the higher land value is the difference in elevation. Lot 1 is located in higher grounds making it less vulnerable to flooding. The other lots are far from the fault line but located in the lower portion of the water catchment area in the vicinity making this lot more vulnerable to flood. The summary of the comparisons between these four lots is shown in Table 2.

**Table 2. Grid Analysis of Industrial Valley Complex Lots**

List of Comparable Characteristics	Comparable 1	Comparable 2	Comparable 3	Comparable 4
Price/sqm	PhP 18,000	PhP 15,000	PhP 16,000	PhP 16,000
Area (sqm)	420	565	300	164
Location	Pres. Aguinaldo	Aquarius St.	Taurus St.	Sagittarius St.
Time of Sale	Recent	Recent	Recent	Recent
Property Rights	Fee Simple	Fee Simple	Fee Simple	Fee Simple
Access	Main Road	Interior Road	Main Road	Main Road
Utilities	All	All	All	All
Topography	Road Level	Road Level	Road Level	Road Level
Zoning	Residential	Residential	Residential	Residential
Traffic	Moderate	Moderate	Moderate	Moderate
Frontage (m)	15	20	15	10
Shape	Rectangular	Rectangular	Rectangular	Rectangular
Elevation	72 ft or 22 m	45 ft or 13.7 m	45 ft or 13.7 m	41 ft or 12.5 m
Distance to Fault	35 m	150 m	130 m	190 m

The validation fieldworks generated some interesting but at the same time disturbing findings. A senior man whose house is traversed by the fault line was in a state of denial about the existence of the fault line. His attitude is understandable but will not do him any good when the big earthquake comes. Some owners are fortunately open minded to accept the fact and even consulted what is supposed to be done in preparation of the “Big One”. There are few who are knowledgeable and did some initiatives in retrofitting their own houses. There are some inspiring acts from people concerned but majority of the players involved have limited or no knowledge at all of the fault line. Worse is an outright neglect of the fault existence and effect. Figure 6 shows a lot which in 2010 is still vacant. The fieldwork conducted in July 2014 exposed the failure of authorities to monitor and prevent the construction of structures directly on top of the fault line. An interview of the condominium personnel proved the ignorance of the stakeholders about the matter.



**Figure 6. Google Map of a Condominium Built on Top of the Fault Line**

A recent fieldwork conducted in March of 2016 has indicated changes in the pricing of affected lots. There are three comparable lots selected to show this effect and are shown in Figure 7 below.



**Figure 7. Map of Comparable Lots in Filinvest 2 Homes**

The three comparable lots are located inside the Filinvest 2 Homes, adjacent the Sunnyside Heights Subdivision, also in the northeastern part of Quezon City. These three selected lots have slight differences in frontage and area but basically share the same characteristics except the last two namely elevation and distance to fault line. The nearer lot to the fault expectedly has lower price than the others and this price difference apparently is attributed to their distance. However, this has to be cross-checked with elevation as it may be the cause of the price difference. A simple verification proved that the lots nearer the fault are relatively flood-free compared to the farther lot. This clearly show the negative effect of the proximity to fault line in the land prices of Metro Manila. Caution has to be observed, however, because these digits presented are asking prices from owners who are trying to recover their land investments and not actual market values. The summary of the comparisons between these two lots is shown in Table 3.

**Table 3. Grid Analysis of Filinvest 2 Homes Lots**

List of Comparable Characteristics	Comparable 1	Comparable 2	Comparable 3
Price/sqm	PhP 8,000	PhP 8,500	PhP 12,000
Area (sqm)	400	380	300
Location	Gold St.	Cohen St.	Chase St.
Time of Sale	For Sale	For Sale	For Sale
Property Rights	Fee Simple	Fee Simple	Fee Simple
Access	Main Road	Main Road	Main Road
Utilities	All	All	All
Topography	Road Level	Road Level	Road Level
Zoning	Residential	Residential	Residential
Traffic	Moderate	Moderate	Moderate
Frontage (m)	20 m	18	15
Shape	Rectangular	Rectangular	Rectangular
Elevation	12 m	12.5 m	8.7 m
Distance to Fault	Directly on Top	2 m	70 m

## 7. CONCLUSION

Lot or property owners and other real estate participants along the West Valley Fault System have limited or no knowledge of the existence of the fault line and the risk of the coming big earthquake as of July 2014. At this stated date, the proximity of the lands to the fault line has no effect on the land values in Metro Manila.

Recent study clearly show the negative effect of the proximity to fault line in the land prices of Metro Manila. However, there is no enough market data to correlate decrease in land values to fault line proximity.

As an offshoot of this study, it is recommended that further research be conducted on the southern portion of the West Valley Fault System and the government must intensify information drive to educate more affected residents.

## 8. ACKNOWLEDGEMENTS

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## BIOGRAPHICAL NOTES

The main author, Florence Galeon, is a licensed geodetic engineer and presently working as an assistant professor at the University of the Philippines. He received his Bachelor of Science in Geodetic Engineering from the University of the Philippines (UP) in Diliman, Quezon City, Philippines and Master of Engineering Science in Remote Sensing from the University of New South Wales (UNSW) in Sydney, Australia in 1989 and 1994 respectively. In 2007, he became Chair of the UP Department of Geodetic Engineering and Director of the Training Center for Applied Geodesy and Photogrammetry (TCAGP). Engr. Galeon's research interests include land valuation, remote sensing and geomatics applications.

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