

## The Tiber Floodplain, Commerce, and Tragedy

The City of Rome is nearly all inundated by water. Along the riverbanks, since 1846, there have been no similar cases where water has risen over a meter above the average level of the river. The Via della Tipografia, where our newspaper is printed, is also under water. The water reached a meter. Piazza Colonna, toward 11 A.M., was under water. At present, flooded are: La Lungara, Piazza della Rotonda, Piazza Pia, Piazza Navona, Piazza Giudia, Piazza Montanara, Il Ghetto, namely, Via Fiumara, Piazza S. Andrea della Valle, Piazza S. Eustachio, Piazza and Via del'Orso, Piazza Campo de' Fiori, and the street of Via Tor di Nona, the Ponte S. Angelo at the Montebianco end, along the Piazza dell' Orso, S. Lorenzo in Città.

*Il Tribuno*, December 28, 1870

WITHOUT AN excellent map and a good sense of direction, you can become thoroughly disoriented as you explore the area of Rome that is on the Tiber's floodplain. One solution is to stay on the busy streets that follow the riverbank (the Lungotevere, "along the Tiber"). The scenery is superb, and you can spend days studying the bridges, but you must eventually enter the districts, such as Trastevere or the Campo de' Fiori, that sprang up along the margins of one of the world's best-known rivers. In search of famous sites in this area, nearly every visitor to the Eternal City ends up at the Pantheon. We begin our visit to the floodplain neighborhoods at Santa Maria Sopra Minerva, which is close to the Pantheon.

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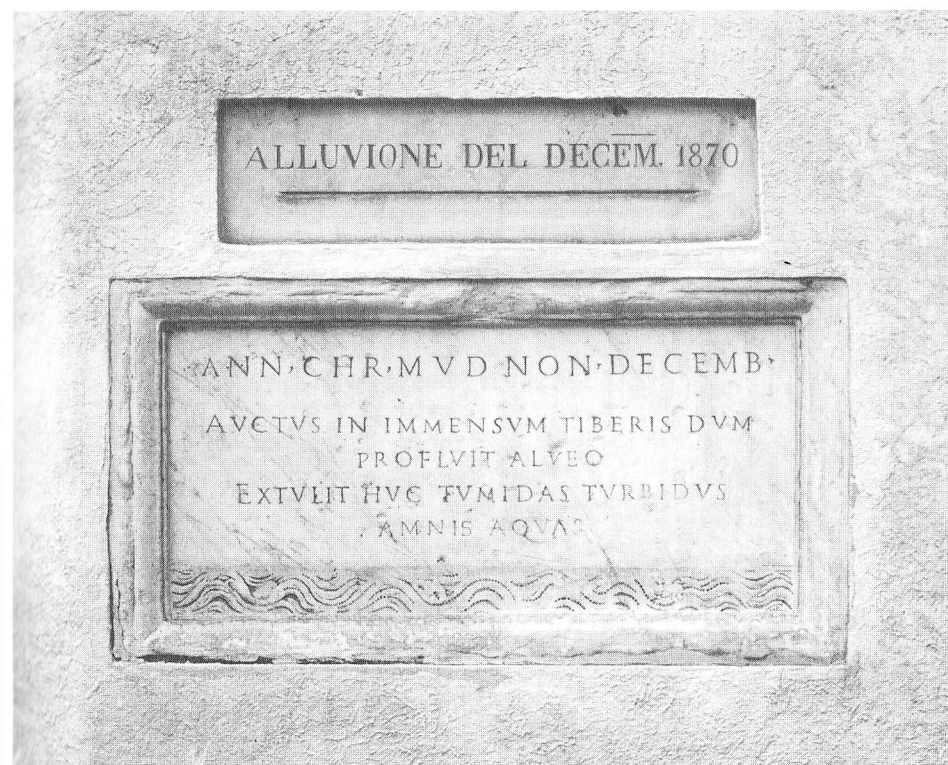
One of the few examples of Gothic architecture in Rome, the Church of Santa Maria Sopra Minerva is in the heart of the historic district.



This splendid old print shows the Piazza Navona during the flood of 1870.

Dating from the 13th century, this beautiful church was built on ancient Roman ruins and possibly on a temple of Minerva. It contains the ornate tombs of the 16th-century Medici popes Leo X and Clement VIII, the painter Fra Angelico, and Saint Catherine of Siena.

In addition to its historical and artistic treasures, Santa Maria Sopra Minerva displays a record of flooding and highlights the uneasy relationship that has long existed between the city and the Tiber River. Stone tablets attached to the church facade by the Dominican order



Plaques on the facade of the Church of Santa Maria Sopra Minerva mark the water depths during major floods of the Tiber River. The highest plaque records a water depth of 3.95 meters (13 feet) in the Piazza di Minerva for the flood of December 24, 1598—an event that devastated central Rome.

chart water depths during past floods. The worst inundation occurred on December 24, 1598, when floodwaters were 3.95 meters (13 feet) deep in the Piazza di Minerva. Try to imagine your favorite tourist destinations surrounded by water, including the Pantheon, Piazza del Popolo, Piazza Navona, and Castel Sant'Angelo.

Stone tablets located throughout Rome on both sides of the Tiber record the highest levels reached by floods. A systematic flood record remains in the Piazza del Porto Ripetta, on the left bank of the Tiber near Ponte Cavour, a minor landing place for boats and barges when the river was still navigable. Lest the citizens of Rome forget about the flood threat, the architect Alessandro Specchi constructed the Ripetta



The Ripetta column is located in the Piazza del Porto di Ripetta, a former river port on the left bank of the Tiber, near the Ponte Cavour. The column was constructed by the architect Alessandro Specchi in 1704 to mark water levels during floods of 1495, 1537, and 1660 and is annotated with the names of popes during those flood years.

column in 1704 to mark water levels during the floods of 1495, 1537, 1660, and 1805. Much of what we know about these Tiberian floods is based on a thorough and patient integration of historical records kept by the National Hydrographic Service and the Hydrographic Office of Rome. Fifteen floods were described by Roman writers, including Livy, who wrote of a flood in 192 B.C.: “The river with much force and violence, much greater than in the previous year, burst through the city, knocking down over two bridges and many buildings—above all in the Porta Flumentana” (from Bencivenga et al. 1995).

Damage during Imperial Roman times was less devastating because of competent city planners, who placed facilities such as theaters and athletic training centers on the floodplain and located most residences above the rogue waters. During medieval times and later, uncontrolled growth extended the city’s neighborhoods across the floodplain to the Tiber’s banks, and eventually much of the population was exposed to flooding. Records from medieval times are spotty and include emotional observations such as “serpents and dragons in the river.” A more objective and realistic—albeit less entertaining—description of the flood of 1277 is inscribed on a stone tablet located under the L’Arco dei Bianchi: “Arrived here the turbid Tiber and withdrew quickly in the year of Our Lord 1277 from the second to the seventh day of the month of November, when it withdrew” (from Bencivenga et al. 1995).

The effects of floods highlighted by the stone tablets of Santa Maria Sopra Minerva are clearly and succinctly presented in writings of their times:

*October 8, 1530.* “There was already at sunrise on Saturday morning, the eighth of October, when the Tiber moved out of its usual bed, beginning ‘mountains’ of water, much to the surprise of everyone—Thus began the wretched river’s flooding of the city before midday and reaching all the sewers, the cellars, and the lowest places, a little after was seen the water overcoming the houses like a betrayal, and hidden power with torrents beginning to seize the steps and undercut all of the roads with great fury that seemed to chisel away at the city’s foundations.” (L. Gomez, 1531, from Bencivenga et al. 1995)

*September 15, 1557.* “Toward midnight, the Tiber rose and flooded a large part of the City. This sudden, unexpected catastrophe did not allow anyone



time to save their possessions. The vineyards near the Castel Sant'Angelo were eroded away by the violent currents and the inhabitants took refuge on their roofs. On the left side in the ditch, water reached the heights of 1530. In the Plaza of St. Peter's you could go by boat. After 24 hours the water began, little by little, to recede and the poor then evaluated the damage. There was total destruction of the Ponte di S. Maria and the new moles along the Tiber. There was damage to the Ponte Fabricio, the passage from Castel Sant'Angelo to the Vatican and the new fortification of the city. There was near collapse of the Convent of S. Bartolomeo on the Tiber Island and in some cases, the palazzos." (L. V. Pastor, *Storia di Papa*, vol. 4, 1944, from Bencivenga et al. 1995)

*December 23, 1598.* "The evening of the 23rd, the month of December past, the Tiber began to rise out of its bed, no longer below the city, rising continuously till 10 o'clock the following night, putting the city under water, outside the seven mountains and the summits of some places higher in the middle of the city, surpassing the riverbanks and signs of flooding in ancient and modern times, particularly, the plain, more than that which came in the time of Pope Clemente VIIth, in a note from year 1530, was the ruin of the Bridge of Santa Maria, the two arches outside parts of the Ponte Molle, and that of Sant'Angelo, even though it remained, the fury of the water struck the shacks and workshops, this directed at the Castle, which fell in places and was ruined—Submerging forty valuable places that were in Torre di Nona and the countryside—drowned many persons and animals, large and small. This horrendous spectacle was finished by 4 P.M. and in this hour, which was the birth of our Lord Jesus Christ, began to go down, and by Christmas Day, was down three levels. It is said that the sudden flood drowned in this city and surrounding areas 1,400 people." (Anonymous, 1599, from Bencivenga et al. 1995)

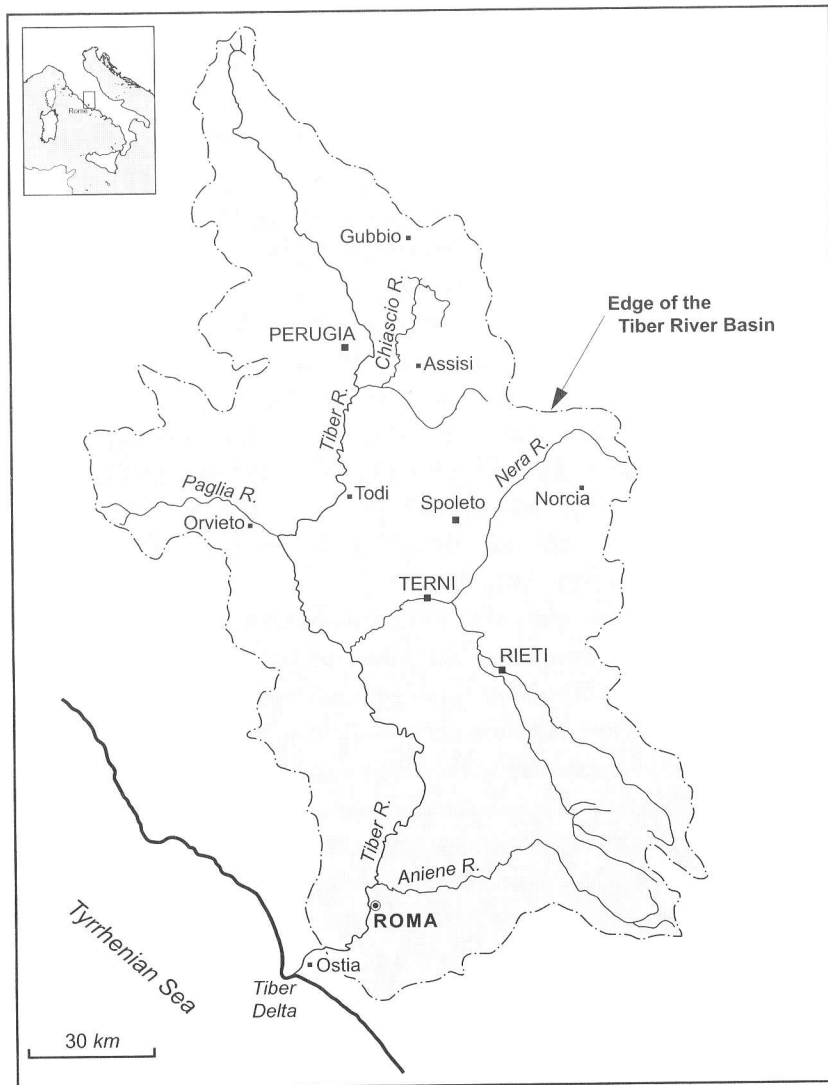
Even as recently as the 19th and the 20th centuries, the floods have caused devastation. There were twenty-eight floods—the highest in 1948, with a flood crest of 18 meters (60 feet). The largest stream flow (with 3,300 cubic meters, or nearly 900,000 gallons, per second) was measured during the flood of 1900, which caused severe damage in the city. However, a more complete warning system had been established after the turn of the century, saving lives along the Tiber's banks.

## WHY SO MANY FLOODS ON THE TIBER AND ITS TRIBUTARIES?

As you walk along paths and streets near the Tiber, notice the walls erected to keep floodwaters from damaging the low-lying parts of the city. Looking at the normally placid river, few people think about its origins. The Tiber River basin is one of the largest on the narrow Italian Peninsula. Because of the area's geologic structure, much of the Tiber's 403-kilometer (250-mile) length runs not perpendicular to the peninsula but parallel to the Apennines across Tuscany, Umbria, and Lazio before entering the sea at Ostia. Much of the Tiber's drainage is located north of Rome, beginning at an elevation of 1,268 meters (4,160 feet) at Monte Fumaiolo and covering an area of 17,156 square kilometers (6,623 square miles) before it reaches the sea near Rome's Fiumicino (Leonardo da Vinci) Airport. In this drainage area, forty-two northern and eastern tributaries feed the Tiber.

Many of the tributary streams south of what is now Rome were cut off when volcanic eruptions in the Alban Hills formed an enormous "dam" of deposits. After the eruptions formed the massif of the Alban Hills, many relatively small streams from their northern and northwestern slopes added their runoff to the Aniene and Tiber rivers. The Alban Hills streams that flowed into Rome have since been diverted or covered during the city's growth. Several of the southern streams, now buried under Rome's suburbs, eroded the tuff plateaus, forming the southern and eastern topographic boundaries of the ancient city; La Marranella flowed northwest, then north, emptying into the Aniene River; it now underlies railroad lines that go north from the city. The Marrana della Caffarella flowed northwest, then west along the southern city wall, under what is now the Central Market, and into the Tiber north of the Basilica of San Paolo fuori le Mura. One of the Alban Hills streams was the Tor Marancia River, which has been diverted to flow under the Via Ardeatina, nearly parallel to the Appian Way. Streams immediately north of the city were less affected by urban growth and are still visible.

Anyone who has lived in central Italy for more than a few months realizes that the weather is tempestuous and difficult to forecast. The Italian Peninsula has all the ingredients necessary to produce flooding: it is flanked by two seas and has a high, mountainous "backbone"—

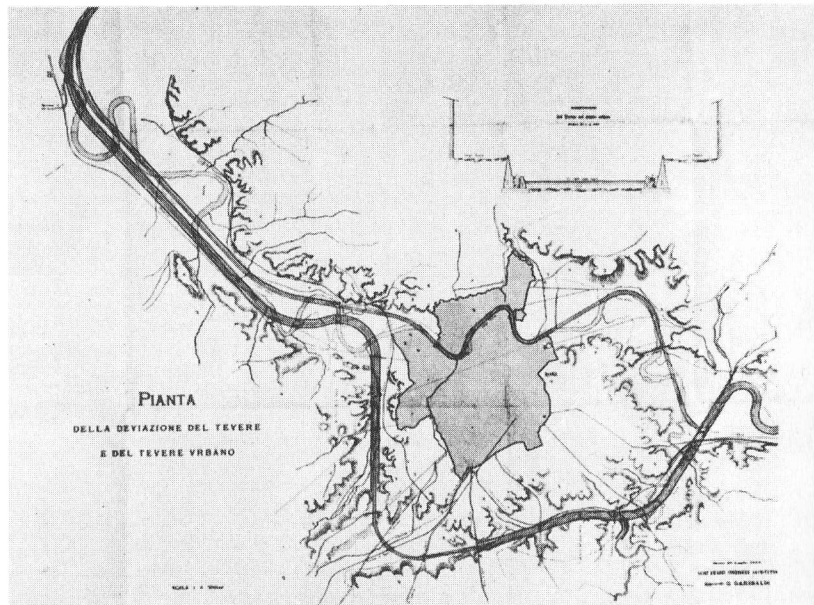


The Tiber River basin is a large north-south network that drains the western slopes of the central Apennines and the volcanic fields between Rome and Tuscany. (Adapted from Bencivenga et al. 1995)

ideal conditions for intense rainfall focused in relatively small areas. Storm clouds laden with moisture come ashore and rise over the central Apennines; the rising, moist air is cooled and begins to condense, producing local rain showers. If the ground is already saturated before a heavy storm, the rainfall flows quickly into rivers rather than being absorbed.

For three days in December 1937, a heavy storm passed over the Tiber basin; total rainfall exceeded 200 millimeters (8 inches) in the mountains north and east of Rome. The subsequent flooding was not the largest that Rome has seen but was important because it was one of the first for which systematic rainfall data were collected. Beginning on December 16, the Tiber reached a level of 16.9 meters (55.5 feet) at the Ripetta column, flowing through the city at 2,800 cubic meters (740,000 gallons) per second. The flooding was recorded on a stone tablet located near the entrance to the Church of San Bartolomeo on the Tiber Island, where water was 80 centimeters (32 inches) above ground level.

Try to imagine it: 17,156 square kilometers (6,623 square miles, an area nearly equal to that of New Jersey) is a lot of territory draining into a single river that runs through Rome. To understand this runoff system, city planners had to integrate many data sets: first, the meteorologic conditions, especially the movement of storms and masses of moist air; second, the topography, which controls the orographic effect (air that is cooled as it rises over the mountains and condensation of water that leads to rain); third, the hydrologic character of geologic units and soils in the region to determine how much water could be absorbed and how much would run off; and last, but not least, a network to monitor rainfall and the stream flow of the Tiber and its many tributaries. Such a sophisticated hydrologic network, now maintained by the National Hydrographic Service, is used for estimating recharge of aquifers and water to be stored for hydroelectric facilities, as well as to determine if and where there will be flooding. Because so much of the runoff from this basin enters the Tiber and passes through Rome, the city has a considerable stake in the success of this monitoring network. Catastrophic floods could destroy not only many neighborhoods but also precious artwork and architectural treasures.



The diversion of the Tiber proposed by colleagues of Garibaldi (the bottom route) followed the natural course of the river as it existed before volcanic activity in the Alban Hills pushed it to the west. That course followed a path to the southeast, behind Rome, below what is now the suburb of Cinecittà (in this case, north is to the right). The plan failed, and the sinuous course above is today's route of the Tiber through Rome.

### THE TIBER FAR AFIELD: FLOODS AND THE DECLINE OF ROMAN COMMERCE

As a part of the modern-day commerce that fuels the Roman economy, international and domestic flights land at Fiumicino Airport every hour of every day. Jet-lagged and distracted passengers arriving on these flights probably aren't very interested in the fact that Fiumicino Airport is located partly on an ancient harbor, the Port of Claudius. This harbor, dredged in A.D. 54, was one of several harbors at the mouth of the Tiber that combined to make Rome a commercial power in the Western world.

One of the best ways to grasp the importance of ancient Rome's early seaports is to take the local train or bus toward the sea to Ostia Antica, another commercial port that is now 4 kilometers (2.5 miles) from



The ancient Roman port city of Ostia, which is now located 4 kilometers (2.5 miles) from the sea, was left landlocked by an ever-growing Tiber River delta. Ostia (now Ostia Antica), as a merchant port where materials were transshipped up the river by barge, was important to the economical and political health of Imperial Rome.

the sea. Ostia's well-preserved theaters, baths, multistory apartment houses, offices, and merchant warehouses give you a good feeling for ancient Roman life in what must have been a bustling, noisy mercantile port city. The population was perhaps 100,000, a very large city for the times. However, the city fell victim to history and the relentless growth of the Tiber delta. The decline began in the 4th century A.D. following a reduction in trade, gradual silting of the harbors, and the spread of malaria, and busy Ostia was gradually abandoned to its now quiet site inland on the Tiber's delta.

### *What Is a River Delta?*

All rivers carry a sediment load: pebbles that scuttle along the riverbed and fine sand and silt that are suspended in the flowing current. The finer-grained sediment is carried as long as the water continues to

move, but when a river reaches a shoreline, as when the Tiber reaches the Tyrrhenian Sea, much of the suspended sediment falls to the bottom in the still water and is thus “deposited.” Some of the sediment is carried along the shore by currents and wave action, which feed and maintain beaches. Continual sedimentation at a river mouth eventually builds a *delta* (a term derived from the flattened triangular shape, with the river entering at the apex) that continues to expand into the sea. The growth and shape of a delta depend, in part, on the size of the river and its sediment load. In the case of the Tiber, however, a rising and falling sea level also affected the delta’s growth. Over the last 13,000 years, the Tyrrhenian Sea has risen 67 meters (220 feet) to its present level. When the sea level was much lower, the Tiber was cutting a deep channel through what is now Rome, so the delta was also much lower and closer to Rome.

You probably won’t be able to see the Tiber delta unless you are looking at a map or satellite image. The distance from the coast to where the river debouches from the hills that flank it is 13 kilometers (8 miles). The delta has 30 kilometers (18.6 miles) of coastline and an area of 150 square kilometers (58 square miles); below sea level, the delta covers an additional 500 square kilometers (193 square miles). All the flat land along the Tiber between southwestern Rome and the Fiumicino Airport is on the delta, where it is a mélange of swamp, old sand dunes, reclaimed farmland, and slow-moving drains or creeks.

To unravel the Tiber’s complex history and understand the growth of the delta, you must think of it in terms of four dimensions: length, width, depth, and time. A team of geologists, geophysicists, and historians from the University of Rome–La Sapienza, led by Piero Bellotti, recently studied the Tiber delta’s history, using data from 226 wells, sea-floor samples, geophysical surveys, and archeological information from the last 2,500 years. They concluded that the delta is a mixture of deposits left by the river and coastal plain over the last 800,000 years, and many of the lateral and vertical variations in the deposits are linked to the rise and fall of sea level. The Tiber delta that we see today is part of the most recent depositional sequence (over the last 100,000 years). Carbon-14 dating has added detail about the last 13,000 years, a time of gradual sea-level rise.

We are fortunate also to have written records from the 3rd century B.C. to the 4th century A.D. to chronicle the delta’s steady forward march. Roman writers, including Pliny the Elder and Plutarch, described the Tiber of their time as a calm river with few floods; they speak of a harbor city at its mouth (Ostia), which was founded in the 4th century B.C.

During the 1st century B.C., when the Tiber rarely flooded, Julius Caesar intended to reclaim the coastal area not connected with the river, which at the time had begun to silt up. Claudius eventually constructed a harbor north of the river mouth between A.D. 42 and 54, and Trajan enlarged it by adding a hexagonal basin in A.D. 110, creating what was the largest man-made harbor in the world. The harbor was connected to the Tiber by a canal (the “Fiumicino”) that eventually gave the river a second mouth; this change has since modified the delta’s shape. Pliny the Younger, who was active in the late 1st–early 2nd century, owned a villa near Ostia that overlooked the sea; today, the ruins of his villa are several hundred meters from the sea and provide mute evidence of the delta’s growth.

Information about the delta is sparse for the time after the fall of the Roman Empire (A.D. 476). Papal bulls of about A.D. 1000 note that Claudius’s harbor was partly filled with silt, the harbor of Trajan was a lake, and the Tiber now had a second, well-defined mouth. Beginning in 1420, the popes constructed watchtowers at the river’s mouth; by 1773, a sequence of six had been built to protect the continually expanding shoreline.

Historians and scientists have studied the Tiber delta since the 18th century. Its growth has been the main focus, but since the 1960s, research has also evaluated the effect of dams on the Tiber, which have reduced the river’s sediment load, slowed delta growth, and enhanced beach erosion. Reforestation, reclamation of coastal marshes, and quarrying the riverbed for sand and gravel have also affected sediment volume.

Bellotti and his coworkers established a link between floods on the Tiber and the delta’s geologic history by showing that a period of rapid delta growth during the 15th through 19th centuries corresponds to a period when frequent floods afflicted Rome, and Europe experienced the “Little Ice Age.”

## CHAPTER FIVE

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As you wander through the maze that is Rome on the floodplain, watch for the many escapes to higher ground via streets that follow the now well-hidden tributaries of the Tiber. These tributaries were once intermittent streams, sometimes requiring a boatman to cross, and some were stagnant, poorly drained marshes.