Dynamic Leveling of the Kanto Basin, Japan:

A Unified Model Linking the Kanto Fragment and *Mw 8* Deep Earthquakes

Author

Hiraoka, Yoshikazu

Affiliation

Independent Researcher, Nishinomiya, Japan

Contact

hiraoka.yoshikazu@nifty.com

ORCID

https://orcid.org/0009-0006-9470-3373

Date

August 1, 2026

This manuscript is a preprint submitted to EarthArXiv. It is intended for submission to Journal of Geophysical Research: Solid Earth.

Abstract

The Kanto Basin in central Japan has preserved an anomalously flat surface for more than one million years, defying the intense compressional tectonic regime of the Japanese island arc. Conventional static sedimentation and sea-level fluctuation models cannot adequately explain this long-term planar stability. This study proposes a dynamic leveling mechanism driven by two interacting deep tectonic processes: the stress-shielding effect of the rigid Kanto Fragment, an isolated Pacific Plate slab embedded beneath the basin, and the episodic occurrence of *Mw 8*–class deep earthquakes along its boundary. By integrating GNSS-derived rigid-body motion of the basin with geotechnical principles—including liquefaction, lateral spreading, and differential consolidation—we construct a unified conceptual model for basin-scale dynamic reorganization. Large deep earthquakes periodically induce forced fluidization of the 3–4 km thick unconsolidated sedimentary sequence, three-dimensional lateral flow governed by gravitational potential gradients, and differential consolidation driven by sediment-load contrasts. Acting synergistically, these processes reset topographic irregularities produced by static sedimentation, functioning as a long-term natural leveling engine. The model provides a coherent explanation for the preservation of elevated tablelands as remnants of former leveled surfaces and reframes the geomorphic evolution of the Kanto Basin as a dynamic, earthquake-driven system rather than a static depositional environment. This framework also carries significant implications for seismic hazard assessment in the Tokyo metropolitan region.

Key Points

- The Kanto Basin's anomalously flat geomorphology is explained by repeated Mw 8 deep earthquakes interacting with the rigid Kanto Fragment.
- Forced fluidization, lateral spreading, and differential consolidation reorganize the 3–4 km unconsolidated sedimentary sequence during each deep-earthquake cycle.
- Tablelands represent preserved remnants of former leveled surfaces, while lowlands remain active dynamic leveling zones susceptible to future deep-earthquake reorganization.

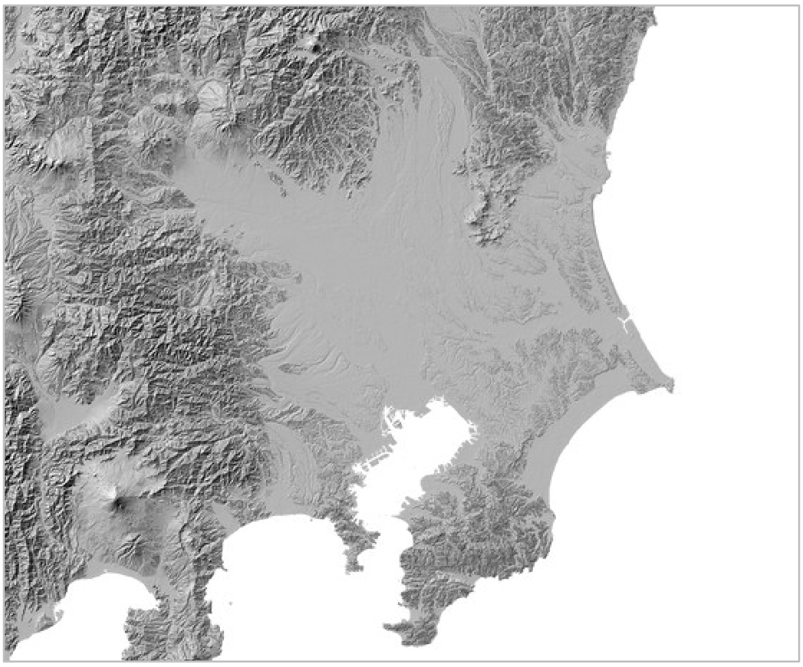
Plain Language Summary

The Kanto Basin in Japan is unusually flat, despite being located in one of the most tectonically active regions in the world. This study proposes that large deep earthquakes, occurring beneath the basin, periodically shake and reorganize its thick layers of soft sediment. During these events, the sediments temporarily behave like a fluid, flowing and settling into a flatter shape. A rigid slab of old oceanic plate beneath the basin, known as the Kanto Fragment, helps focus stress and trigger these earthquakes. Over hundreds of thousands of years, repeated deep earthquakes have acted like a natural "leveling machine," keeping the basin flat. Higher tablelands around the basin are older surfaces that escaped later reshaping. This model may help improve understanding of earthquake hazards in the Tokyo region.

1. Introduction

This study addresses a fundamental geological paradox: the Kanto Basin has continued to subside throughout the Quaternary while exhibiting almost no large-scale folding, warping, or structural deformation. Instead, it has maintained an exceptionally flat surface over more than one million years. This persistent flatness is highly unusual for an active forearc basin situated within one of the strongest compressional tectonic regimes in the Japanese island arc.

Figure 1. Shaded relief map of the Kanto Basin and surrounding regions.



Source: GSI Maps (Geospatial Information Authority of Japan).
The conical mountain in the lower-left portion of the figure is Mount Fuji.

The Kanto Basin—geographically recognized as the Kanto Plain—is not only the largest lowland region in Japan, located in the central part of Honshu, but also one of the most anomalously planar sedimentary basins among global subduction zones. Under typical tectonic conditions, unconsolidated Quaternary sediments subjected to strong horizontal compression from the subducting Pacific Plate (≈8 cm/yr) and Philippine Sea Plate (≈3–4 cm/yr) are expected to undergo buckling, folding, and uplift over timescales of tens to hundreds of thousands of years. Such basins normally evolve into ridge-and-valley topography or low mountain ranges through progressive structural deformation.

However, no such large-scale fold-and-thrust topography is observed across the central Kanto Basin. Conventional explanations—fluvial sediment supply from surrounding mountains and sea-level fluctuations during glacial–interglacial cycles—fail to account for the basin's long-term planar stability. From a geotechnical perspective, unconsolidated sands, silts, and clays possess inherent internal friction angles and therefore cannot maintain a perfectly flat surface under purely static sedimentation; natural levees, fan gradients, and micro-relief inevitably develop.

The Kanto Basin is not a delta apex but a massive sedimentary container filled with 3–4 km of unconsolidated deposits. Its extraordinary flatness cannot be attributed to human land-leveling, nor can it be explained by static depositional processes alone. A large-scale physical mechanism capable of periodically resetting surface irregularities must exist in the subsurface.

Modern geodetic observations offer critical insights into this anomaly. Continuous GNSS data from GEONET reveal that the Kanto Basin moves as a coherent rigid block, exhibiting uniform northwestward displacement with negligible internal strain. This behavior is mechanically anomalous for a thick, low-rigidity sedimentary basin.

The underlying cause of this rigid-body motion is the presence of the **Kanto Fragment**—a horizontally embedded, high-rigidity slab of Pacific Plate origin located at depths of 40–100 km beneath the basin. Acting as a structural shield, the fragment absorbs and redirects regional compressional stress, preventing the overlying sediments from undergoing tectonic buckling.

This study builds upon the hypothesis that the Kanto Fragment not only provides static protection against horizontal compression but also drives **dynamic leveling** of the basin surface through episodic *Mw 8*–class deep earthquakes. By integrating geodetic observations with geotechnical principles such as liquefaction, lateral spreading, and differential consolidation, we propose a unified dynamic model that explains the long-term flatness of the Kanto Basin as the product of repeated earthquake-driven reorganization rather than static sedimentation.

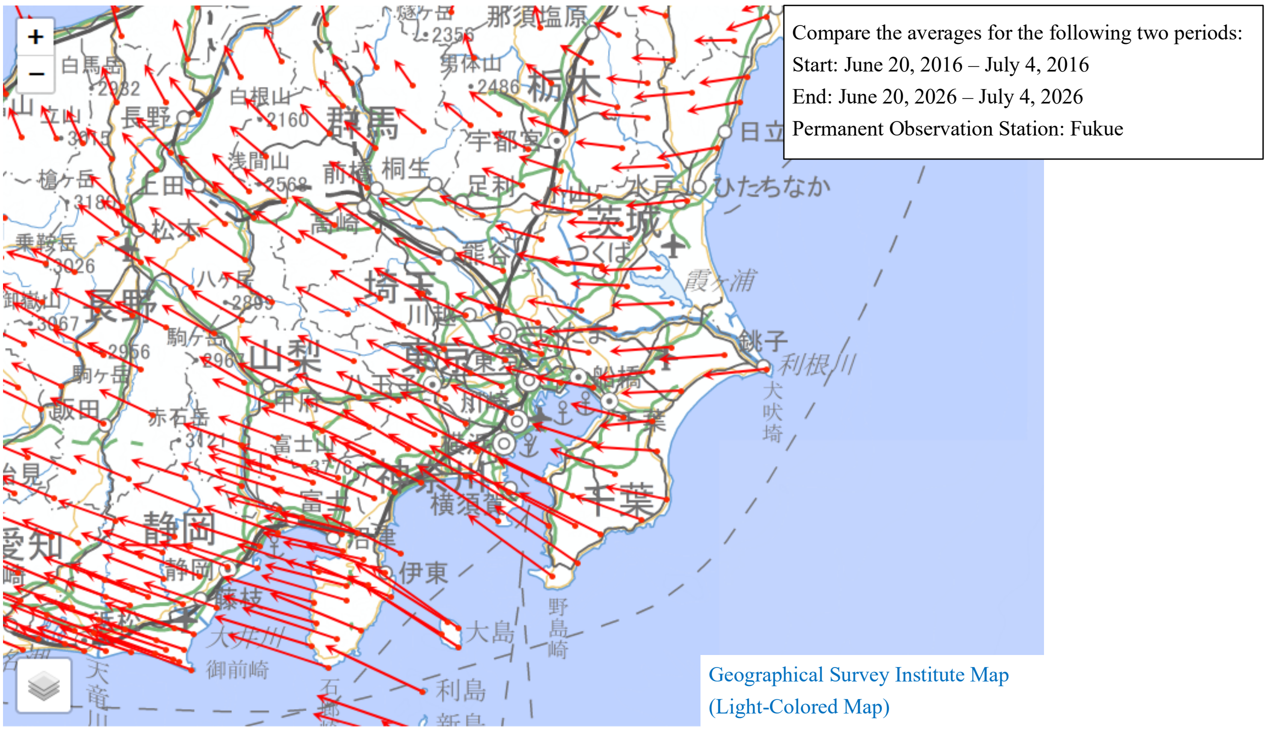
2. Geological and Geophysical Background

The Kanto Basin is composed of thick unconsolidated sediments deposited from the late Neogene through the Quaternary, including the Kazusa Group, the Narita Group, and the overlying alluvial formations. In the central part of the basin—beneath Saitama, Kasukabe, and the northern margin of Tokyo Bay—these deposits reach a maximum thickness of 3,000–4,000 m. From a geotechnical perspective, these units remain only partially consolidated and exhibit low elastic moduli, behaving mechanically as a vast body of soft sediments.

Under normal tectonic conditions, such a thick accumulation of unconsolidated material subjected to strong horizontal compression from the subducting Pacific Plate (≈8 cm/yr) should develop significant internal strain. Over geological timescales, this strain would typically produce folding, reverse faulting, and large-scale buckling, ultimately generating ridge-and-valley topography or low mountain ranges. This is the expected mechanical response of a forearc basin under sustained multi-axial compression.

However, modern geodetic observations contradict this expectation. Continuous GNSS measurements from GEONET reveal that the Kanto Basin exhibits remarkably uniform northwestward displacement with negligible internal deformation. The basin behaves as a coherent rigid block, despite being composed of low-rigidity sediments several kilometers thick. This rigid-body motion is mechanically anomalous and requires a structural explanation.

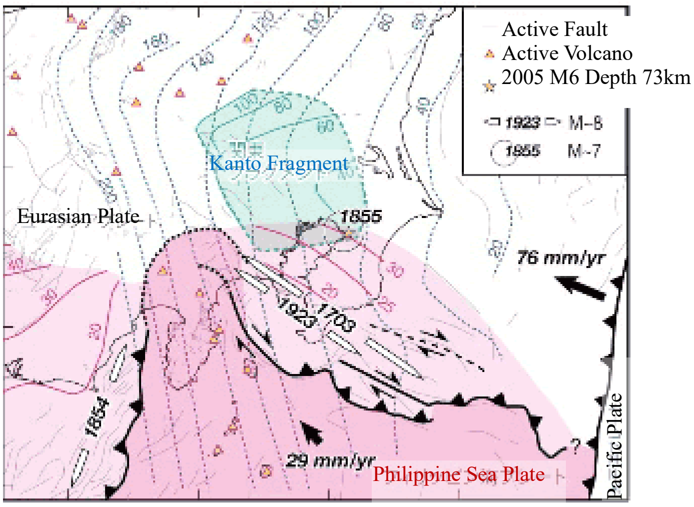
Figure 2. Horizontal crustal deformation vectors in the Kanto Plain and surrounding regions from 2016 to 2026.



Source: Modified from the Geospatial Information Authority of Japan, Crustal Deformation Visualization System.

The key to this behavior lies in the presence of the **Kanto Fragment**, a horizontally embedded, high-rigidity slab of Pacific Plate origin located at depths of approximately 40–100 km beneath the southern and central Kanto region of Japan. The fragment is estimated to be roughly 100 km long, 100 km wide, and 25 km thick. Geological and geophysical studies suggest that it originated from a complex triple-junction interaction among the Pacific, Philippine Sea, and North American plates, becoming detached and fixed within the upper mantle beneath the basin.

Figure 3. Revised plate model incorporating the Kanto Fragment. Contour lines and numerical labels indicate the depth to the upper surface of each plate.



The light green shading represents the surface projection of the Kanto Fragment. The light red shading represents the Pacific Plate, while the dark red shading indicates the Philippine Sea Plate. Contour lines and numerical labels denote the depth to the upper surface of each plate.
Source: Modified from Shinji Toda, "Plate Structure Beneath the Tokyo Metropolitan Area and Expected Earthquake Scenarios."

The Kanto Fragment functions as a **static stress-shielding structure** that protects the overlying sediments from direct tectonic compression. Its mechanical effects can be summarized as follows:

Shielding of horizontal tectonic stress. The immense compressional force exerted by the Pacific Plate is intercepted by the eastern margin of the fragment rather than being transmitted directly into the sedimentary basin. The fragment absorbs and redistributes this stress, preventing the development of large-scale folding in the overlying deposits.

Rigid-base protection. The fragment and its associated basement rocks form a mechanically robust "pallet" beneath the basin. Because this pallet does not deform under horizontal compression, the unconsolidated sediments above it are shielded from buckling and remain mechanically isolated from regional tectonic strain.

Thus, the rigid-body motion observed in GNSS data does not imply that the sediments themselves are rigid. Instead, it indicates that the entire basin is being transported atop a deep, high-rigidity structural plate that prevents internal strain accumulation.

This static protection, however, does not eliminate tectonic stress. Compression continues to accumulate along the boundaries of the Kanto Fragment, particularly where it contacts the subducting Pacific Plate. Over geological timescales, this stress builds to the elastic limit and is released episodically as ***Mw 8*–class deep earthquakes**. These events generate intense seismic pulses propagate vertically through the overlying sedimentary basin, triggering dynamic processes that reorganize the basin surface.

This geological and geophysical framework establishes the foundation for the dynamic leveling model proposed in this study.

3. Dynamic Leveling Model

The static stress-shielding effect of the Kanto Fragment prevents the thick unconsolidated sediments of the Kanto Basin from undergoing tectonic buckling. However, this shielding does not eliminate regional compressional stress. Instead, strain accumulates along the fragment's boundaries—particularly at its interface with the subducting Pacific Plate—over geological timescales. When this strain reaches the elastic limit, it is released episodically as ***Mw 8*–class deep earthquakes**, generating intense seismic pulses that propagate upward into the overlying 3–4 km thick sedimentary sequence.

These episodic pulses act as dynamic forcing events that reorganize the basin surface. The dynamic leveling mechanism proposed in this study consists of **three interacting geotechnical processes**, each triggered by large deep earthquakes and collectively capable of flattening basin-scale topography.

Before discussing these processes, it is important to note that seismic waves entering the 3–4 km thick unconsolidated sedimentary layers of the Kanto Basin undergo strong amplification due to basin-edge effects. As the waves encounter the sharp impedance contrast at the basin margins, seismic energy becomes trapped and repeatedly reflected within the low-velocity sediments. This reverberation transforms the incoming motion into long-period, large-amplitude shaking that can persist for several minutes. The resulting sustained cyclic shear stresses propagate throughout the entire sedimentary column, rapidly increasing pore-water pressure and driving the deposits toward a near-zero effective stress state—a critical precursor to basin-wide liquefaction and forced fluidization.

3.1 Forced Fluidization and the Loss of Internal Friction

Under static fluvial deposition, unconsolidated sands, silts, and clays possess inherent internal friction angles that produce natural micro-relief such as fan gradients and levee ridges. However, during an *Mw 8* deep earthquake, the sedimentary sequence is subjected to intense cyclic shear stresses lasting several minutes. These stresses disrupt grain interlocking and cause excess pore-water pressure to rise explosively until it approaches total overburden stress.

At this point, the effective stress within the sediment approaches zero, thereby triggering **complete liquefaction and fluidization**. In this state, the sediment behaves as a frictionless granular fluid with an effective internal friction angle of zero. Consequently, the liquefied mass flows downslope according to gravitational potential gradients, producing **three-dimensional lateral spreading** toward basin depocenters and toward the lower-pressure region of Tokyo Bay.

This forced fluidization eliminates the stabilizing effect of frictional strength and allows previously stable micro-topography to collapse and redistribute.

3.2 Differential Consolidation Driven by Sediment-Load Contrasts

Static sedimentation produces spatially variable sediment loads, with thicker deposits forming local topographic highs. During a large deep earthquake, liquefaction and disturbance of the sedimentary layers trigger rapid dissipation of excess pore-water pressure through vertical and lateral drainage pathways. This process is accompanied by intense dewatering and degassing (including methane release), resulting in volumetric contraction. The magnitude of consolidation (ΔH) is proportional to both the thickness of the sediment column and the differential effective stress. Thus, **areas with greater initial sediment load undergo larger consolidation**, while thinner or lower-load areas experience smaller settlement. This negative feedback mechanism automatically reduces topographic contrasts: thick, elevated deposits subside more, while thinner deposits remain relatively unchanged.

Through repeated earthquake cycles, differential consolidation progressively flattens the basin surface.

While differential consolidation reduces topographic contrasts over repeated earthquake cycles, it does not by itself flatten the basin surface. Because the magnitude of consolidation (ΔH) scales with the initial sediment thickness (H), the thickest deposits near the basin depocenter undergo the largest settlement. This process deepens the central basin rather than producing a level surface. Basin-scale leveling is therefore governed primarily by lateral spreading, in which liquefied sediments flow toward gravitational lows and fill local depressions. Differential consolidation acts subsequently as a secondary smoothing mechanism, reducing residual micro-relief after lateral redistribution has occurred. Clarifying this hierarchy of processes—lateral spreading as the dominant leveling agent and differential consolidation as a longer-term fine-adjustment—resolves the apparent contradiction between load-dependent settlement and the preservation of a planar basin surface.

3.3 Geological Evidence: Slump Structures and Layered Disturbance

The dynamic leveling model is strongly supported by geological evidence from borehole cores in the central Kanto Basin. Sedimentary sequences of the Kazusa Group, which should exhibit orderly horizontal bedding under static marine deposition, frequently contain **slump structures, disrupted layering, and horizontally stretched or homogenized units**.

These features indicate basin-wide liquefaction, lateral flow, and internal deformation consistent with repeated

large-magnitude seismic disturbance. Their widespread occurrence suggests that *Mw 8*–class deep earthquakes have repeatedly reorganized the sedimentary basin over hundreds of thousands to millions of years.
Furthermore, the Kanto Plain's extraordinary flatness cannot be attributed to anthropogenic land-leveling, as the region historically lacked extensive agricultural modification. The persistence of planar topography therefore reflects a natural, long-term dynamic leveling system driven by deep tectonic processes.

Summary of the Dynamic Leveling Engine

Together, the three processes—forced fluidization, three-dimensional lateral spreading, and differential consolidation—form a **synergistic dynamic leveling engine**. Each earthquake acts as a basin-wide reset mechanism, eliminating micro-relief generated by static sedimentation and restoring a flat surface. Over geological timescales, repeated *Mw 8* deep earthquakes produce the anomalously planar geomorphology observed across the Kanto Basin today.

4. Discussion

The dynamic leveling model proposed in this study conceptualizes the geomorphic evolution of the Kanto Basin as a long-term energy-conversion system linking deep tectonic processes to surface reorganization. Rather than interpreting the basin as a passive sedimentary container shaped solely by fluvial deposition and sea-level fluctuations, this framework emphasizes the role of episodic deep earthquakes as active agents of geomorphic resetting.
Under typical forearc conditions, multi-axial horizontal compression from the Pacific and Philippine Sea plates would generate significant internal strain within the basin's unconsolidated sediments, producing folding, reverse faulting, and progressive uplift. However, the presence of the Kanto Fragment fundamentally alters this expected trajectory. Acting as a rigid structural pallet and stress shield, the fragment intercepts and absorbs regional tectonic compression, preventing strain accumulation in the overlying sediments. As a result, the basin remains mechanically isolated from direct tectonic deformation.
Yet the tectonic energy is not eliminated; it is **stored**. Compression is transferred to the fragment's boundaries, where strain accumulates until it is released as *Mw 8*–class deep earthquakes. These earthquakes represent a **dynamic conversion** of long-term tectonic stress into short-duration seismic pulses. When these pulses propagate upward into the 3–4 km thick sedimentary sequence, they trigger forced fluidization, lateral spreading, and differential consolidation—processes that collectively flatten the basin surface.
Thus, the long-term flatness of the Kanto Basin can be understood as the outcome of a cyclical energy pathway:
Tectonic horizontal compression → strain accumulation in the Kanto Fragment → *Mw 8* deep earthquakes → basin-scale dynamic leveling.
This three-stage system links deep tectonics, intermediate-depth slab fragments, and surface geomorphology into a coherent energy-dissipation mechanism.

4.1 Earthquake-Driven Surface Reorganization as a Basin-Scale Process

The dynamic leveling mechanism operates at the scale of the entire basin. Each *Mw 8* deep earthquake acts as a basin-wide reset event, eliminating micro-relief generated by static sedimentation. Over hundreds of thousands to millions of years, repeated cycles of liquefaction, lateral flow, and consolidation produce the anomalously planar geomorphology observed today.

This interpretation reframes the Kanto Basin not as a static depositional environment but as a **dynamically reorganized landscape**, periodically reshaped by deep tectonic pulses. The basin's flatness is therefore not a passive outcome but an active product of repeated seismic forcing.

4.2 Tablelands and Lowlands as a Temporal Mosaic of Leveling Surfaces

The model also provides a unified explanation for the spatial arrangement of elevated tablelands—such as the Musashino, Omiya, and Shimosa Uplands in the Kanto region of Japan—and the lowlands that separate them. These tablelands can be interpreted as **preserved remnants of former leveled surfaces** produced during past deep-earthquake cycles.

Once a leveled surface is uplifted or isolated by river incision or local structural movements, it becomes physically separated from subsequent lateral-flow pathways and liquefaction zones. As a result, these elevated surfaces escape later dynamic leveling events and retain the geomorphic signature of earlier cycles.

In addition to geomorphic isolation, the tablelands possess geotechnical properties that make them significantly less susceptible to basin-wide liquefaction during deep earthquakes. The water table beneath the uplands is generally much lower than in the surrounding lowlands, reducing pore-water pressure buildup during cyclic shaking. Furthermore, the upper portions of the Narita Group and related formations are comparatively denser and more consolidated than the younger alluvial deposits that dominate the lowlands. These factors increase the liquefaction resistance of the tablelands, allowing them to remain mechanically stable even when the deeper 3–4 km sedimentary sequence undergoes forced fluidization and lateral spreading. As a result, once uplifted or isolated, the tablelands avoid subsequent participation in basin-scale sediment redistribution and preserve the geomorphic signature of earlier leveling cycles.

In contrast, the present-day lowlands—particularly along major river corridors and coastal zones—represent **active leveling surfaces**, continually reorganized by ongoing sedimentation and susceptible to future dynamic leveling during deep earthquakes.

This temporal mosaic of preserved and active leveling surfaces explains the basin's characteristic pattern of tablelands and lowlands without invoking complex tectonic uplift or differential erosion models.

4.3 Implications for Basin Evolution and Seismic Hazard

The dynamic leveling model has significant implications for both geomorphology and seismic hazard assessment. It suggests that:

- The Kanto Basin's flatness is a product of **repeated deep-earthquake forcing**, not static sedimentation.
- Tablelands represent **geomorphic archives** of past leveling events.
- Lowlands are **current dynamic surfaces** that will be reorganized again during future *Mw 8* deep earthquakes.
- The basin's thick unconsolidated sediments are highly sensitive to deep seismic pulses, with potential for widespread liquefaction, lateral spreading, and consolidation.

These insights highlight the need to incorporate deep-earthquake dynamics into models of basin evolution and urban seismic risk, particularly in the Tokyo metropolitan region.

5. Conclusion

This study proposes a dynamic leveling model that integrates geophysical, geological, and geotechnical processes to explain the long-term planar geomorphology of the Kanto Basin. Despite residing within one of the strongest compressional tectonic regimes in the Japanese island arc, the basin has maintained an anomalously flat surface for more than one million years. Conventional static sedimentation and sea-level fluctuation models cannot account for this persistent flatness.

The model presented here identifies the **Kanto Fragment**, a rigid slab of Pacific Plate origin embedded at depths of 40–100 km, as the key structural element responsible for shielding the basin's thick unconsolidated sediments from direct tectonic compression. GNSS observations demonstrating basin-wide rigid-body motion support the interpretation that the fragment acts as a deep structural pallet and stress shield.

However, tectonic stress is not eliminated; it accumulates along the fragment's boundaries and is episodically released as ***Mw 8*–class deep earthquakes**. These earthquakes convert long-term tectonic compression into short-duration seismic pulses that propagate upward into the 3–4 km thick sedimentary sequence. The resulting forced fluidization, three-dimensional lateral spreading, and differential consolidation act synergistically to flatten the basin surface. Over geological timescales, repeated cycles of dynamic leveling have produced the basin's present-day planar morphology.

This framework also provides a coherent explanation for the geomorphic contrast between elevated tablelands and adjacent lowlands. Tablelands represent preserved remnants of former leveled surfaces that became isolated from subsequent dynamic leveling, whereas lowlands constitute active leveling surfaces continually reorganized by ongoing sedimentation and susceptible to future deep-earthquake forcing.

The dynamic leveling model fills a long-standing gap in the understanding of Kanto Basin evolution, reframing the region not as a static depositional environment but as a landscape shaped by episodic deep tectonic pulses. It also carries significant implications for seismic hazard assessment in the Tokyo metropolitan area of Japan, where thick unconsolidated sediments may undergo widespread liquefaction, lateral spreading, and consolidation during future *Mw 8* deep earthquakes.

Future work should focus on two key areas: (1) chronological analysis of slump structures and disturbed layers in deep borehole cores to establish correlations with past deep-earthquake cycles, and (2) three-dimensional coupled fluid–solid numerical simulations to quantify the extent of surface leveling produced by *Mw 8* seismic pulses. Together, these efforts will help refine and validate the dynamic leveling model and deepen our understanding of the tectonic and geomorphic processes shaping the Kanto Basin.

Acknowledgments

The conceptual foundation of this study is deeply rooted in the author's personal experience during the 1995 Hyogo-ken Nanbu (Kobe) earthquake, which revealed the overwhelming power of seismic events and the vulnerability of human society. Since that time, a sustained desire to understand the physical mechanisms underlying crustal deformation and earthquake generation—particularly in domains that remain scientifically unresolved—has guided the author's long-term inquiry.

Although the author is not formally affiliated with academic institutions in seismology, geology, or geotechnical

engineering, this work was made possible through the integration of publicly available high-precision geophysical data and fundamental principles of soil mechanics. The continuous GNSS observations provided by the Geospatial Information Authority of Japan (GSI) through the GEONET network have been indispensable in shaping the ideas presented in this study. The author expresses profound gratitude to GSI, the National Institute of Advanced Industrial Science and Technology (AIST), and all research institutions that maintain and openly share geophysical and geological datasets essential for advancing public scientific understanding.
The author also acknowledges the contributions of numerous researchers whose studies on the tectonic structure of the Kanto region, deep earthquakes, and sedimentary basin dynamics have provided critical context and inspiration. Their work forms the scientific foundation upon which this study builds.
Finally, the author hopes that the insights offered here will contribute, even in a modest way, to the ongoing efforts to better understand the subsurface structure beneath the Tokyo metropolitan area and to support future initiatives in seismic hazard mitigation and disaster resilience.

Data Availability Statement

All data used in this study are publicly available from the Geospatial Information Authority of Japan (GSI), the National Institute of Advanced Industrial Science and Technology (AIST), and other cited sources. No new datasets were generated for this research.

Conflict of Interest Statement

The author declares no conflicts of interest.

Funding Statement

This research received no external funding.

Author Contribution Statement

Y. Hiraoka conceived the study, conducted the analysis, and wrote the manuscript.

References

Cabinet Office, Government of Japan. (n.d.). Fault modeling in earthquake disaster reduction [in Japanese]. Retrieved from https://www.bousai.go.jp/

Suzuki, H. (2002). Subsurface geological structure of the Kanto Plain [in Japanese]. Report of the National Research Institute for Earth Science and Disaster Prevention, 63, 1–20.

Geospatial Information Authority of Japan (GSI). (2011–2026). GEONET: Continuous GNSS observation data for crustal deformation in Japan [in Japanese]. Retrieved from https://www.gsi.go.jp/

Toda, S. (2014). Plate structure beneath the Tokyo metropolitan area and expected earthquake scenarios [in Japanese]. Journal of Japan Association for Earthquake Engineering, 20, 1–10.

Toda, S. (2015). Hidden plate fragment beneath the Tokyo region and its seismogenic implications [in Japanese]. National Institute of Advanced Industrial Science and Technology (AIST). Retrieved from https://www.aist.go.jp/

Kitada, S., et al. (2018). Fundamental study on post-earthquake ground settlement mechanisms in the Kashiwazaki Plain [in Japanese]. Nagaoka University of Technology, Department of Environmental and Civil Engineering.

EarthArXiv Preprint Statement