# DIGITAL PARTICIPATORY VILLAGE PLANNING MODEL FOR SUSTAINABLE DEVELOPMENT OF RURAL COMMUNITY

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# DIGITAL PARTICIPATORY VILLAGE PLANNING MODEL FOR SUSTAINABLE DEVELOPMENT OF RURAL COMMUNITY

*by*

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**CENTRE FOR RURAL DEVELOPMENT AND TECHNOLOGY**

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***in fulfilment of the requirements for the degree of***

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*Dedicated to my loving family:*

*Parents*

*(Late Shri. Pannalal Bandyopadhyay &*

*Smt. Mahimamoyee Bandyopadhyay),*

*Husband*

*(Dr. Sandeep Kumar Raut)*

*and daughter*

*(Shrimoyee)*

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## CERTIFICATE

This is to certify that the thesis entitled, "**Digital Participatory Village Planning Model for Sustainable Development of the Rural community**", being submitted by Ms. Papiya Bandyopadhyay Raut to the Indian Institute of Technology Delhi for the award of " Doctor of Philosophy" is a record of bonafide research work carried by her. She has worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis. To the best of my knowledge, the results contained in the thesis have not been submitted in part or full to any other university or institute for the award of any other degree or diploma.

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**(Papiya Bandyopadhyay Raut)**

# ABSTRACT

Since independence, India's Five-Year Plans have emphasized agricultural development, employment generation, rural infrastructure, and institutional strengthening through integrated rural development programmes. Despite these sustained efforts, the country's ranking of 132 in the Human Development Index (2023) reflects persistent challenges in improving rural quality of life. A major limitation has been the inadequate integration of grassroots participation and community empowerment in planning processes, raising concerns regarding sustainability, inclusiveness, and long-term socio-economic transformation. Achieving the Sustainable Development Goals (SDGs) requires addressing economic disparities, climate risks, technological gaps, and infrastructure deficits through innovative and participatory development frameworks.

In this context, the concept of smart and sustainable rural communities, supported by national initiatives such as Digital India and Smart Village programmes, offers new opportunities to integrate Information and Communication Technologies (ICT), spatial intelligence, and community-based decision-making into rural planning. This research proposes a Digital Participatory Village Planning (DPVP) Model, integrating IoT-enabled platforms, GIS-based spatial planning, and participatory rural appraisal techniques to facilitate inclusive, transparent, and data-driven village development. The study focuses on the Gaindikhata cluster in Haridwar district, Uttarakhand, a rural region experiencing socio-economic stagnation despite proximity to the rapidly growing urban centre of Haridwar.

The DPVP model combines a Digital Participatory Inclusive Framework with a Sustainable Physical Planning approach to analyse the ecological–economic–cultural dynamics of rural settlements. Primary data were collected through extensive field investigations, including household surveys, participatory rural appraisal, transect walks, and opinion polls across twenty-four villages. A Core Community Group comprising Local Community Fielders and Local Community Leaders was established to ensure effective grassroots engagement, overcome digital access limitations, and harness local knowledge. Spatial and non-spatial datasets were integrated using GIS tools to evaluate land use patterns, resource distribution, and development potential.

The research undertakes a comprehensive analysis of rural community systems, ecological conditions, and land-use arrangements, including physiography, drainage, forest cover, climate, population dynamics, and socio-economic characteristics. Key challenges identified include inefficient water management, limited livelihood opportunities, and severe land pressure due to forest dominance and restricted arable land. Carrying capacity assessments were conducted to evaluate sustainable thresholds for water, food, and fodder resources at both village and cluster levels. Resource potential analysis highlighted opportunities in agriculture diversification, horticulture, medicinal plants, community forestry, floriculture, and eco-tourism.

The proposed DPVP Model emphasises smart techno-ecological integration, circular economy principles, and participatory governance to promote resource efficiency, environmental conservation, and climate-resilient development. A sustainable land-use development plan up to the year 2034 is proposed, incorporating diversified livelihood strategies, off-farm activities, and multipurpose land management practices. Overall, the DPVP Model demonstrates how digital participatory approaches can enhance community empowerment, strengthen local planning capacities, and facilitate inclusive, sustainable, and economically viable rural transformation.

# सारांश

स्वतंत्रता के बाद से, भारत की पंचवर्षीय योजनाओं में एकीकृत ग्रामीण विकास कार्यक्रमों के माध्यम से कृषि विकास, रोजगार सृजन, ग्रामीण अवसंरचना और संस्थागत सुदृढ़ीकरण पर जोर दिया गया है। इन निरंतर प्रयासों के बावजूद, मानव विकास सूचकांक (2023) में देश की 132वीं रैंकिंग ग्रामीण जीवन स्तर में सुधार लाने में लगातार चुनौतियों को दर्शाती है। एक प्रमुख बाधा नियोजन प्रक्रियाओं में जमीनी स्तर की भागीदारी और सामुदायिक सशक्तिकरण का अपर्याप्त एकीकरण रहा है, जिससे स्थिरता, समावेशिता और दीर्घकालिक सामाजिक-आर्थिक परिवर्तन को लेकर चिंताएं बढ़ रही हैं। सतत विकास लक्ष्यों (एसडीजी) को प्राप्त करने के लिए नवीन और सहभागी विकास ढांचों के माध्यम से आर्थिक असमानताओं, जलवायु जोखिमों, तकनीकी कमियों और अवसंरचना की खामियों को दूर करना आवश्यक है।

इस संदर्भ में, डिजिटल इंडिया और स्मार्ट विलेज कार्यक्रमों जैसी राष्ट्रीय पहलों द्वारा समर्थित स्मार्ट और टिकाऊ ग्रामीण समुदायों की अवधारणा, सूचना और संचार प्रौद्योगिकी (आईसीटी), स्थानिक बुद्धिमत्ता और समुदाय-आधारित निर्णय लेने को ग्रामीण नियोजन में एकीकृत करने के नए अवसर प्रदान करती है। यह शोध समावेशी, पारदर्शी और डेटा-संचालित ग्राम विकास को सुगम बनाने के लिए आईओटी-सक्षम प्लेटफार्मों, जीआईएस-आधारित स्थानिक नियोजन और सहभागी ग्रामीण मूल्यांकन तकनीकों को एकीकृत करते हुए एक डिजिटल सहभागी ग्राम नियोजन (डीपीवीपी) मॉडल प्रस्तावित करता है। यह अध्ययन उत्तराखंड के हरिद्वार जिले के गैंदीखाता क्लस्टर पर केंद्रित है, जो हरिद्वार जैसे तेजी से बढ़ते शहरी केंद्र के निकट होने के बावजूद सामाजिक-आर्थिक ठहराव का सामना कर रहा एक ग्रामीण क्षेत्र है।

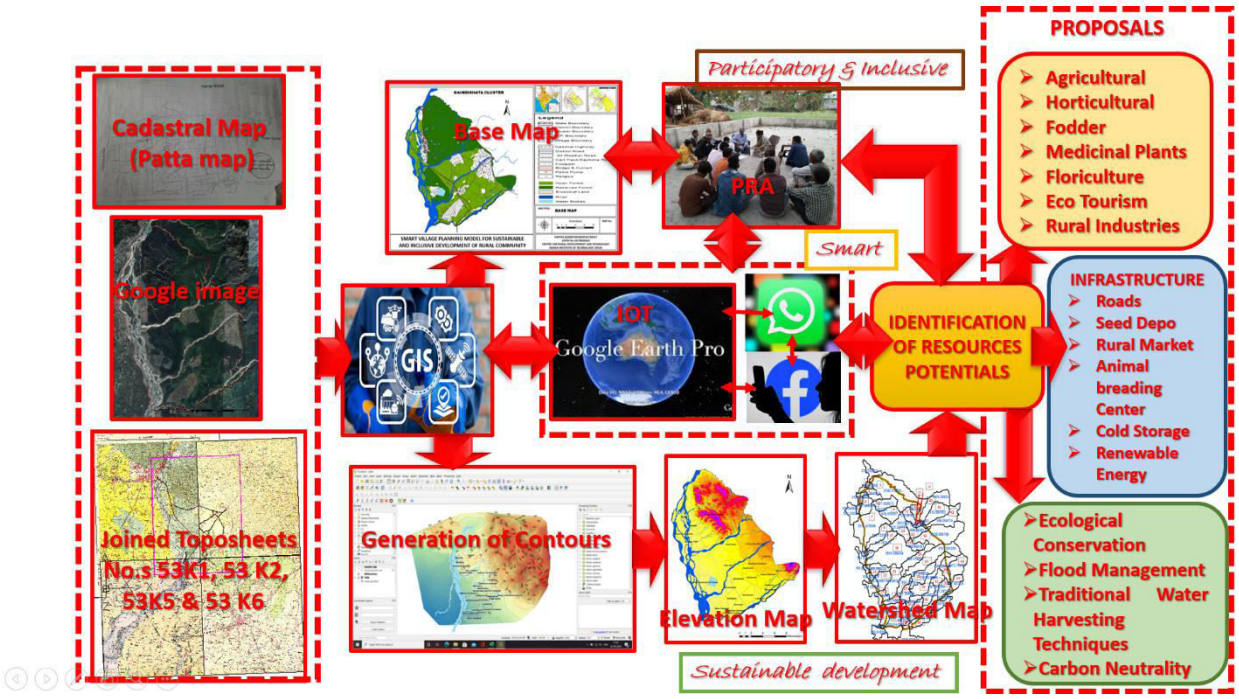
डीपीवीपी मॉडल ग्रामीण बस्तियों की पारिस्थितिक-आर्थिक-सांस्कृतिक गतिशीलता का विश्लेषण करने के लिए डिजिटल सहभागी समावेशी ढाँचे को सतत भौतिक नियोजन दृष्टिकोण के साथ जोड़ता है। प्राथमिक डेटा चौबीस गाँवों में व्यापक क्षेत्र सर्वेक्षणों के माध्यम से एकत्र किया गया, जिसमें घरेलू सर्वेक्षण, सहभागी ग्रामीण मूल्यांकन, सर्वेक्षण और जनमत सर्वेक्षण शामिल थे। प्रभावी जमीनी स्तर की भागीदारी सुनिश्चित करने, डिजिटल पहुँच की सीमाओं को दूर करने और स्थानीय ज्ञान का उपयोग करने के लिए स्थानीय सामुदायिक कार्यकर्ताओं और स्थानीय सामुदायिक नेताओं से मिलकर एक मुख्य सामुदायिक समूह की स्थापना की गई। भूमि उपयोग पैटर्न, संसाधन वितरण और विकास क्षमता का मूल्यांकन करने

के लिए जीआईएस उपकरणों का उपयोग करके स्थानिक और गैर-स्थानिक डेटासेट को एकीकृत किया गया।

इस शोध में ग्रामीण सामुदायिक प्रणालियों, पारिस्थितिक स्थितियों और भूमि उपयोग व्यवस्थाओं का व्यापक विश्लेषण किया गया है, जिसमें भू-आकृति विज्ञान, जल निकासी, वन आवरण, जलवायु, जनसंख्या गतिशीलता और सामाजिक-आर्थिक विशेषताएं शामिल हैं। पहचानी गई प्रमुख चुनौतियों में अक्षम जल प्रबंधन, सीमित आजीविका के अवसर और वनों की प्रधानता तथा सीमित कृषि योग्य भूमि के कारण भूमि पर अत्यधिक दबाव शामिल हैं। ग्राम और समूह दोनों स्तरों पर जल, खाद्य और चारा संसाधनों के लिए सतत सीमा का मूल्यांकन करने हेतु वहन क्षमता आकलन किया गया। संसाधन क्षमता विश्लेषण ने कृषि विविधीकरण, बागवानी, औषधीय पौधों, सामुदायिक वानिकी, पुष्पकृषि और पर्यावरण पर्यटन में अवसरों को उजागर किया।

प्रस्तावित डीपीवीपी मॉडल संसाधन दक्षता, पर्यावरण संरक्षण और जलवायु-लचीले विकास को बढ़ावा देने के लिए स्मार्ट तकनीकी-पारिस्थितिक एकीकरण, चक्रीय अर्थव्यवस्था सिद्धांतों और सहभागी शासन पर जोर देता है। वर्ष 2034 तक एक सतत भूमि उपयोग विकास योजना प्रस्तावित की गई है, जिसमें विविध आजीविका रणनीतियों, गैर-कृषि गतिविधियों और बहुउद्देशीय भूमि प्रबंधन प्रथाओं को शामिल किया गया है। कुल मिलाकर, डीपीवीपी मॉडल दर्शाता है कि कैसे डिजिटल सहभागी दृष्टिकोण सामुदायिक सशक्तिकरण को बढ़ा सकते हैं, स्थानीय नियोजन क्षमताओं को मजबूत कर सकते हैं और समावेशी, टिकाऊ और आर्थिक रूप से व्यवहार्य ग्रामीण परिवर्तन को सुगम बना सकते हैं।

# GRAPHICAL ABSTRACT



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# LIST OF ABBREVIATIONS

| | |
|---|---|
| **CM** | Centimeter |
| **CNFC** | Carbon Neutral Facilitation committee |
| **DPVP** | Digital Participatory Village Planning |
| **DPVPM** | Digital Participatory Village Planning Model |
| **ERND** | Engineering Research and Development. |
| **EU** | European Union |
| **GIS** | Geographic Information System |
| **GSDR** | Global Sustainable Development Report |
| **HCM** | Hectare to centimeter |
| **HECT** | Hectare |
| **HH** | Household |
| **HMNEH** | Horticulture Mission for North East and Himalayan States |
| **IOT** | Internet of Things |
| **IT** | Information and Communication technology |
| **JFM** | Joint Forest Management |
| **KM** | Kilometer |
| **KWH** | Kilowatt-hour (kWh) |
| **LCF** | Local Community fielder |
| **LCL** | Local Community leader |
| **MDG** | Millenium Development Goal |
| **MGNREGA** | Mahatma Gandhi National Rural Employment Guarantee Act |
| **MORD** | Ministry of Rural Development |
| **MSME** | Ministry of Micro, Small & Medium Enterprises |
| **MT** | Metric Ton |
| **NRLM** | National Rural Livelihood Mission |
| **NTFP** | Non-Timber Forest Produce |
| **PMGY** | Pradhan Mantri Gramin Yojna |
| **PPP** | Public-Private Partnership: |
| **PURA** | Provision of Urban amenities in Rural area |
| **RS.** | Rupees. |
| **SAGY** | Sansad Adarsh Gram Yojana |

| | |
|---|---|
| **SDG** | Sustainable Development Goal |
| **SOC** | Soil organic carbon |
| **SPMRM** | Shyama Prasad Mukherji Rurban Mission |
| **SQ. KM** | Square kilometer |
| **UN** | United Nation |
| **UNCSD** | United Nations Conference on Sustainable Development |
| **UNDESA** | United Nations Department of Economic and Social Affairs |
| **UT** | Union Territory |
| **UVA** | Unnat Bharat Abhiyan |