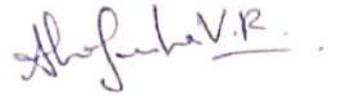


DECLARATION

I, hereby declare that this thesis entitled “**Groundwater Modelling using WetSpas-M and MODFLOW**” is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Place: Tavanur

Date: 24/02/2026



AKANSHA V R

(2023-18-002)

CERTIFICATE

Certified that this thesis entitled “Groundwater Modelling using WetSpas-M and MODFLOW” is a record of research work done independently by Er. Akansha V R (2023-18-002) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

Place: Tavanur

Date: 24.02.2026



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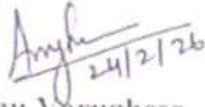
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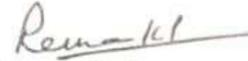
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We, the undersigned members of advisory committee of Er. Akansha V R (2023-18-002), a candidate for degree of Master of Technology in Agricultural Engineering with major in Soil and Water Conservation Engineering, agree that the thesis entitled "GROUNDWATER MODELLING USING WETSPASS-M AND MODFLOW" may be submitted by Er. Akansha V R (2023-18-002) in partial fulfilment of the requirement for the degree.


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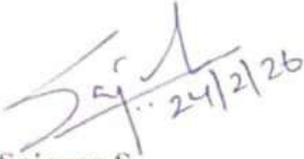
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Acknowledgement

ACKNOWLEDGEMENT

First and foremost, I bow in deep gratitude to the Almighty for His boundless blessings, mercy, and guidance, which have been a constant source of strength throughout the course of my academic journey and in the successful completion of this research work.

I am profoundly thankful to my Major Advisor, **Dr. Anu Varughese**, Associate Professor, Department of Irrigation and Drainage Engineering, KCAEFT, Tavanur, for her continuous guidance, insightful suggestions, and support provided throughout the course of this study. Her expertise, encouragement, and mentorship have been instrumental to the progress and successful completion of this study. I consider it as a great privilege to have worked under her supervision and remain sincerely grateful for the academic and professional growth I have achieved under her guidance.

I extend my sincere thanks to **Dr. Jayan P. R.**, Dean of Faculty, KCAEFT, Tavanur, for his constant support and encouragement throughout the course of my research.

I would also like to extend my sincere thanks to the members of my advisory committee **Dr. Rema K.P.**, Professor & Head, Department of Irrigation and Drainage Engineering, KCAEFT, Tavanur, **Dr. Sajeena S.**, Professor, Department of Irrigation and Drainage Engineering, **Mr. Vaisakh Venu.**, Assistant Professor and Head, Department of Basic Engineering and Applied Sciences for their constructive comments, expert guidance, and valuable time. Their insightful suggestions at various stages of my work greatly enhanced the quality and direction of this study, and I am deeply grateful for their continuous support.

I would like to express my special thanks to **Dr. Khatawkar Dipak Suresh**, Assistant Professor, Department of Farm Machinery and Power Engineering, KCAEFT, Tavanur for his valuable help and guidance in Python coding for the WetSpas-M analysis. His technical support and clear explanations greatly assisted me in completing the modelling work successfully.

I gratefully acknowledge the **Pattambi Meteorological Department**, for providing the necessary facilities and support required for the execution of this research.

I am deeply grateful to my parents **Mr. Vaithianathan** and **Mrs. Ratha** and my brother **Er.Akash** for their unconditional love, constant encouragement, and endless support throughout the course of my study. Their faith in me has been my greatest strength, and I owe much of this achievement to their care and motivation.

I would like to express my heartfelt thanks to **Dr. Aravind P**, my senior, for his continuous guidance and support throughout my work. His practical suggestions, timely help, and constant encouragement have been truly valuable, and I am grateful for the assistance he provided during the entire course of this study. I would also like to extend my heartfelt thanks to my senior **Er. Dixita Gourshetty** for her guidance and encouragement, which have played a vital role in shaping this work.

I would also like to thank my senior **Er. Hasna Ameena P.O.** and my friends **Er. Devika Guguloth**, **Er. Naveen S**, **Er. Velmurugan E** and **Er.Jazal K.T.** for their support and help during data collection. I would also like to express my gratitude to my friends **Er. Mahantesh Ganigi** and **Er. Nagaarjun K.** Their cooperation, encouragement, and involvement made the field work much easier and greatly contributed to the progress of this study.

Last but not the least, I am deeply thankful to God for giving me the strength, guidance, and blessings that enabled me to complete this work successfully. His grace has been my support throughout every stage of this journey.

Akansha V R

*Dedicated to my
parents and teachers*

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LIST OF SYMBOLS AND ABBREVIATIONS

ASTER	: Advanced Space-borne Thermal Emission and Reflection Radiometer
ArcGIS	: Geographic Information System software by ESRI
CGWB	: Central Ground Water Board
°C	: Degree Celsius
DEM	: Digital Elevation Model
DOI	: Digital Object Identifier
EC	: Electrical Conductivity
ET	: Evapotranspiration
ET ₀	: Reference Evapotranspiration
ESRI	: Environmental Systems Research Institute
FEFLOW	: Finite Element subsurface FLOW system
GEE	: Google Earth Engine
GIS	: Geographic Information System
GW	: Groundwater
h	: Hydraulic head
H ₀	: Null hypothesis
H ₁	: Alternative hypothesis
h ₁ , h ₂	: Hydraulic heads at two points
IAHS	: International Association of Hydrological Sciences
IDW	: Inverse Distance Weighting
K	: Hydraulic conductivity
K _{xx} , K _{yy} , K _{zz}	: Hydraulic conductivity in x, y, and z directions
km	: Kilometre
km ²	: Square kilometre
LAI	: Leaf Area Index
LULC	: Land Use Land Cover
mm	: Millimetre (used in rainfall, depth)
m	: Metre
m/day	: Metres per day

m ³	: Cubic metre
m ³ /day	: Cubic metre per day
MK	: Mann–Kendall test
MODFLOW	: Modular Finite-Difference Groundwater Flow Model
MODFLOW Flex	: Visual MODFLOW Flex
MODIS	: Moderate Resolution Imaging Spectroradiometer
MT3D	: Modular 3-Dimensional Transport Model
N	: Number of observations
NDBI	: Normalized Difference Built-up Index
NDVI	: Normalized Difference Vegetation Index
n _e	: Effective porosity
n	: Porosity
NRMSE	: Normalized Root Mean Square Error
PET	: Potential Evapotranspiration
pH	: Hydrogen ion concentration
Q	: Groundwater Discharge
R	: Groundwater recharge
R ²	: Coefficient of determination
RMSE	: Root Mean Square Error
RS	: Remote Sensing
S _s	: Specific storage coefficient
S _y	: Specific yield
SWIR	: Shortwave Infrared
SRTM	: Shuttle Radar Topography Mission
USGS	: United States Geological Survey
WetSpass	: Water and Energy Transfer between Soil, Plants and Atmosphere under quasi-Steady State
WetSpass-M	: Modified WetSpass Model
Z	: Standardized Mann–Kendall test statistic
%	: Percentage
μm	: Micrometre

