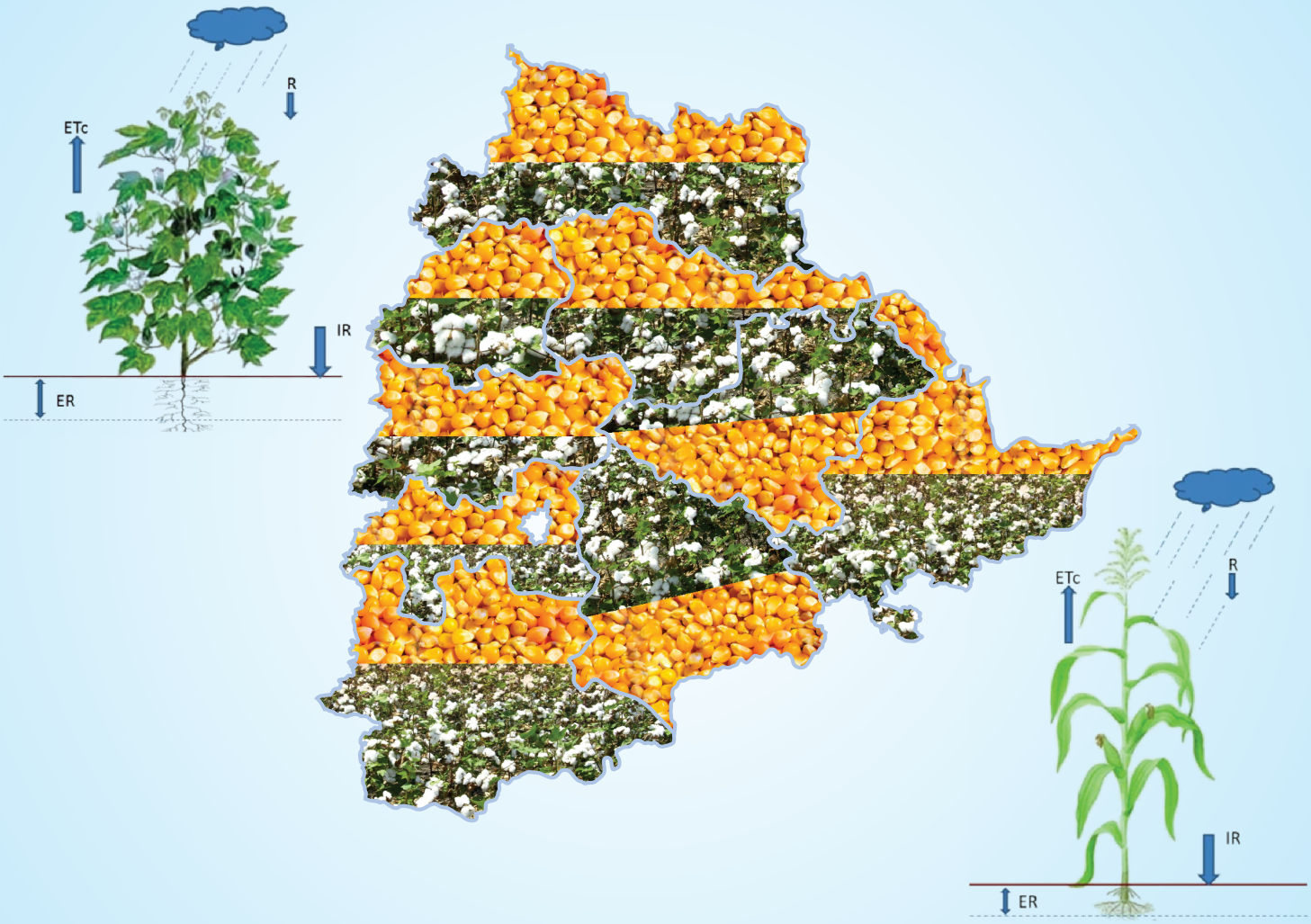
ATLAS on

Climate Change Impacts on Crop Water Balance of Cotton (*Gossypium herbaceum*) and Maize (*Zea mays L.*) in Telangana



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National Innovations on Climate Resilient Agriculture
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Citation:

Reddy K S, Kumar M, Maruthi V, Ravi Kumar N, Maheswari M, Sikka A K, Lakshminarayana P, Vijayalakshmi, Umesha B and Reddy Y V K (2015). Atlas on Climate Change Impacts on Crop Water Balance of Cotton (*Gossypium herbaceum*) and Maize (*Zea mays L.*) in Telangana. ICAR-Central Research Institute for Dryland Agriculture, Hyderabad PP:174

Copies : 200

Published by

The Director

ICAR-Central Research Institute for Dryland Agriculture
Hyderabad - 500059, India
Ph: 040-24530177 Fax: 040-24531802
Website : http://www.crida.in
Email: director@crida.in

ISBN No: 978-93-80883-32-8

Cover page by K S Reddy and P Lakshminarayana

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Printed at
Heritage Print Services Pvt. Ltd.
B-11/9, Modern Bread Lane, IDA, Uppal, Hyderabad - 500 039, Phone : 040-27201927

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कृषि अनुसंधान और शिक्षा विभाग एवं
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FOREWORD

Agriculture is an important sector of Indian economy. In addition to providing food and nutritional security, it also provides employment to half the population and 14% national GDP. Agriculture is however, depends on specific climatic conditions and any variation in climate significantly influences agricultural production, consumption, price and even trade. Most of 90 million Indian households, who depend on agriculture, hold less than 0.4 ha farm. These are mostly rainfed and people are practicing sustenance farming. The adverse effects of climate change on agriculture makes farming more vulnerable. Water resource development and management assumes major role in achieving resilience in agriculture and thus sustainability in food production. The Telangana state has 10 districts, has 72 % of cultivable area is under rainfed. Thus, holistic utilization of natural resources vis- a- vis management assumes significant prominence in these areas to translate agriculture towards sustainability and climate resilience.

Cotton, rice and maize are emerging as important crops apart from pulses and coarse grains in Telangana and cotton (14.0 lakh ha) and maize (4.5 lakh ha) are mostly grown in rainfed situations. The productivity of these crops can be enhanced substantially with the adoption of better water management strategies. Water balance modelling provides an inside look into the soil-plant-water-climate relationship and quantification of different parameters, support effective crop planning and resource optimization. These are indeed helpful in achieving enhanced productivity with resilience in agriculture.

The present atlas, documents the likely decadal changes in crop water parameters including rainfall, effective rainfall, crop evapotranspiration and irrigation requirements. The outcome are the compilation of results of crop water modeling using projected climatic data from IPCC ECHam5 Alb scenario pertaining to 9 rainfed districts of Telangana for maize and cotton crops. The relative changes in these parameters in future 4 decades namely 2011-2020, 2021-2030, 2031-2040 and 2041-2050 have been meticulously computed and presented.

I have firm belief that the outcome embodied in this Atlas would be of immense use to planners in preparing long term policy on water resource development and management from agricultural perspective. It will also be helpful in identifying critical areas for future watershed development plan. I congratulate the authors for bringing this valuable Atlas.

(S. Ayyappan)

Dated the 9th June, 2015
New Delhi

PREFACE

Rainfed agricultural production systems are primarily dependent on climate parameters including rainfall, temperature, wind velocity, sunshine hours/solar radiation etc among which rainfall is the critical input resource. It significantly varies over time and space with erratic distribution having coefficient of variation (CV) in the range of 30 to 80% in all the semi arid regions. The other crop water balance parameters effective rainfall, crop evapotranspiration, irrigation water requirement during crop seasons, have dynamic relationship with the quantity and distribution pattern of rainfall.

IPCC AR5 report indicated the decrease in rainfall in southern part of the country with extreme events of drought, and its frequency, decrease in rainy days which are primarily concerns of rainfed agriculture. The two states of Andhra Pradesh and Telangana have maximum area (67%) under rainfed agriculture with major crops of maize, cotton, groundnut and pigeon pea grown in the 16 districts of two states. Therefore an attempt is made to analyze the decadal variation of crop water balance parameters in 16 districts of Telangana and Andhra Pradesh. The data and its variation are shown in the geospatial maps of Telangana and Andhra Pradesh for easy understanding to the readers in the form of atlas for each state.

The atlas is the outcome of the work related to modeling of crop water balance for maize and cotton crops in rainfed districts of Telangana state. It was an important activity on potential of rainwater harvesting and utilization under NICRA project of ICAR-CRIDA. We thank Dr. S. Ayyappan , Director General, ICAR and Secretary, DARE and Dr. A.K. Sikka, DDG (NRM) for their keen interest, guidance and constant support. We also express our sincere thanks to Director, CRIDA and Principal Investigator, NICRA for extending necessary support and encouragement.

We take this opportunity to thank "Climate Change, Agriculture and Food Security (CCAFS)" for providing base data (1961-1990) and ECHam5 data as open source from Marksim DSSAT. We are also thankful to FAO, Rome for providing CROPWAT V8.0 simulation software.

We also extend thanks to Dr. Abdul Islam for critically evaluating the findings and suggestions to improve upon. We recognize the help rendered by students of College of Agricultural Engineering, Madakasira and Sangareddy.

Authors

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1 Introduction

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period of time. Climate change is caused by factors such as biotic processes, variations in solar radiation, volcanic eruptions, the industrial and air pollution caused by CO_2 and other GHG emissions affecting the climate parameters of temperature, rainfall, crop evapotranspiration and green water within the root zone in various agriculture production systems. The climatic conditions are highly influencing the productivity and agricultural potential of a region and are strongly inter-related. De la Casa and Ovando, 2014 found that the climate conditions are changing in unprecedented way worldwide in the past 70 years. It is likely that the GHG concentration would reach to 685 ppm CO_2 equivalent by 2050. This is higher than the value of 450 ppm to have at least a 50% chance of stabilising the climate at a 2°C global average temperature increase mentioned in 2010 United Nations Framework Convention on climate change (CRIDA, 2013). Global temperature rise is predicted due to the warming of oceans, and change in the hydrological behaviour of the regions caused by climate change. The potential ill effects of global climate change on agriculture in general and rainfed agriculture in particular include frequent and longer periods of drought and increase in duration and intensity of precipitation (IPCC, 2007). These threats are particularly important to the rainfed agriculture of India since it affects the crop water balance of region that contributes 40% of food basket in the country (CRIDA, 2013). Fischer et al., 2007 analysed the climate change impacts on irrigation requirements based on daily water balance and concluded that mitigation strategies of climate can reduce by about 40% in agricultural water requirements as comparison to unmitigated climate. Hence, proper planning on water resource development and management is a key to sustain the production system of Indian rainfed agriculture.

The recent report of IPCC (IPCC, 2014) suggested that the global-scale precipitation to gradually increase in the 21st century with higher precipitation and lower rainy days. Their model predictions indicated, increase in runoff in Northern latitudes and decrease in Southern regions (IPCC, 2014). On a global scale, there are many indications that climate change will continue and could result in major shifts in biomes by the turn of the century (Bergengren et al., 2011; Tebaldi et al., 2006; Oreskes., 2004).

Asian agriculture supporting 63% of global population, is responsible for two thirds of global agricultural GDP (Mendelsohn, 2014) contributing 67% of global agricultural productivity. Water is the major input in agriculture sector as it consumes 70% water as compared to industrial use (19%) and domestic sector (11%) of the total utilisable water (Bruinsma., 2003). The analysis by Schmidhuber and Tubiello, 2007, predicted that the 5 to 200 million people worldwide would be at the risk of hunger by 2100 due to significant adverse impacts of climate change upon crop yield and food security. Climate change and climate variability have been impacting Indian agriculture by changing rainfall which is likely to decline by 5 to 10% over peninsular India whereas, 10 to 20% increase is likely over other regions (CRIDA, 2013). Gosain et al. 2006 studied the climate change effects on Krishna River basin of India and concluded that the flows are reduced significantly. This would impact the efforts in mitigating droughts occurring in both Andhra Pradesh and Telangana states. Chowdhury et al., 2013 analysed the sensitivity of crop growing seasons and found that the shift of wheat growing season might conserve significant amount of groundwater. There are many studies exploring how climate change may affect crops and farmers in China (Wang et al., 2009, 2014; Chen et al., 2013; Holst et al., 2013) and India (Kumar and Parikh., 1998; Sanghi and Mendelsohn., 2008) as well as other Asian countries (Seo et al., 2005).

Two third of the geographical area in India, is prone to drought of varying degrees. Half of these receives rainfall between 750 mm and 1125 mm while other half receiving less than 750 mm are considered drought prone and chronically drought prone respectively (MoWR, 2014). In India, the increased frequency on extreme events of flood and droughts due to climate change, has the potential to reduce more than 20% of crop net revenue. It is further estimated that due to temperature rise of 1.5°C, two thirds of the net revenue would be lost in Asia (Mendelsohn., 2014). Srivastva et al, 2010 found that the impact of climate change on crops grown in India would be more on winter crops in central and south-central zones but in south-west zone, climate change effect is more on monsoon crops.

The climate change projections mostly in terms of annual mean surface air temperature, are likely to impact human health, agriculture, water resources, natural ecosystems, and biodiversity (India's Second National Communication submitted to the UNFCCC). India's first National Action Plan on Climate Change (NAPCC) emphasized the need to evaluate the existing policies and program to develop future plan to address climate mitigation and adaptation. In this report, the key issues identified are reduction in winter rainfall and temperature fluctuations affecting rabi crops in the rainfed areas. Similarly, it is reported that there is a decrease in cropped area in south west monsoon due to insufficient rainfall.

Several studies based on CROPWAT model developed by the Food and Agriculture Organization (FAO) to estimate the crop evapotranspiration, effective rainfall and irrigation requirement during the crop growth period has been reported (Kuo et al., 2006 and Stancalie et al., 2010) along with reliability testing. CROPWAT model has been widely used for predicting reference evapotranspiration, Crop Water requirement (CWR), irrigation rescheduling, deficit irrigation scheduling and cropping patterns in many countries (George et al., 2000, Anadranistakis et al., 2000, Kuo et al., 2006, Wahaj et al., 2007, Kang et al., 2009, Nazeer, 2009, Mimi and Jamous, 2010, Stancalie et al., 2010). Kuo et al., 2006 found that CWR predicted by CROPWAT model was accurate for scheduling irrigation under different water management systems.

For efficient water resource management, the estimates of parameters of crop water balance pertaining to specific crops are mostly desired (Zhang et al., 2010; Anadranistakis et al., 2000). Pleban and Israeli, 1989 advocated on-farm water balance as the normal method for deciding on farm irrigation scheduling. Arora and Gajri, 2000 forecasted maize growth and yield in a subtropical environment by combining a crop growth simulator (SUCROS) with a water balance model (WBM). Bocchiola et al, 2012 studied the effect of prospective climate change (variations in temperature, precipitation, and CO_2) on crop yield and water productivity of maize (*Zea mays L.*) in Po valley of Northern Italy using CropSyst model.

In view of above discussion, it is evident that the assessment of crop water balance components like rainfall, crop evapotranspiration, effective rainfall (Green water) and irrigation water requirement are very important for future planning to enhance water productivity in rainfed agriculture in the context of climate change. The present analysis details these aspects for higher water productivity in Telangana state of southern India in the form of ATLAS. It focussed on the climate change impacts on crop water balance in two showing windows (normal and late) of the two major crops namely Maize (*Zea mays L.*) and Cotton (*Gossypium herbaceum*) in Telangana state.

2 Materials and Methods

2.1 Study area

Rainfed districts Adilabad, Karimnagar, Nijamabad, Warangal, Medak, Khammam, Mahboobnagar, Nalgonda and Rangareddy of Telangana state falls under agro climatic zones of Southern plateau and hills, and East coast plains and hills (ICAR-NARP Classification) were taken for crop water balance study. Maize (*Zea mays L.*) and Cotton (*Gossypium herbaceum*) are the two major crops grown under rainfed kharif are selected for crop water balance analysis. The major soils in the area are red sandy soils. The location map of the study area is given in Fig.2.1.

Fig. 2.1 Location map of the study area

2.2 Input data

Daily climate data used in this study were obtained from MarkSim™ DSSAT weather file generator (web: http://gismap.ciat.cgiar.org/MarkSimGCM/) which uses the well-known MarkSim™ application (Jones & Thornton 2000, Jones et al 2002) working off a 30 arc-second climate surface derived from WorldClim (Hijmans et al., 2005). The Marksim DSSAT Provides the data on rainfall , maximum & minimum temperture and solar radiation on daily basis. MarkSim was developed in the 1980 and 1990 to simulate weather from known sources of monthly climate data from around the world. It divides the world into 720 clusters of climate that were all distinct from one another and fitted a third order Markov model to the precipitation data. The temperature data simulation was derived from SIMMETEO model (Geng et al., 1988). The radiation data were based on the model of Donatelli and Campbell (1997). The downloaded climate data has been compared with observed weather data of Gunegal Research Farm (GRF) for validation. It was found that good agreement between MarkSim base period data and those of observed data of GRF station. More over, MarkSim DSSAT data are from globally valid models that do not need recalibration every time (Marksim web). In the present study, the base period (1961-1990) and projected period (2011-2050) climate data of ECHam5 model (Roeckner et al. 2003) for A1b scenario (As usual case) is used. Though there are several GCM models providing downscale geospatial climate data from the MarkSim DSSAT, the ECHam5 for A1b scenario was preferred due to its more prominent use in climate change analysis

(Kumar et al.2013; Kolli et al. 2006; Almazroui. 2013; Gerten et al., 2011; Bouwer et al. 2006; Kazmi et al. 2014; Park et al.2011; Conde et al. 2011; Ines and Hansen. 2006; Dobler and Ahrens.2010; Henriksson et al.2011).

The different sowing windows for the cotton and maize are taken from contingency manual of peninsular India (Prasad et al. 2012). The climate data and crop parameter sources are given in Table 2.1. The crop coefficients used in CROPWAT model are given in Table 2.2. The crop sowing windows of ctton and maize are given in Table 2.3.

Table 2.1. Climate data and crop parameter sources

Parameters	Source	Model
Precipitation, minimum and maximum temperature, solar radiation	Marksim^{TM} DSSAT weather file generator	ECHam5, A1b Scenario
Crop type, crop sowing dates	Contingency Plan, CRIDA	--
Crop Parameters (K_c, stage, rooting depth, crop height, and growth period)	FAO-CROPWAT model	CROPWAT V8.0

Table 2.2. Crop coefficients used in CROPWAT model

Crop	Parameter	Season					
		Initial	Development	Mid	Late	Harvest	Total days
Cotton	K_c values	0.35	---	1.2	---	0.6	---
	Stage (Days)	30	50	55	45	---	180
	Rooting Depth (m)	0.3	---	---	1.4	---	---
	Crop height (m)		---	1.3	---	---	---
Maize	Kc values	0.3	---	1.2	---	0.85	---
	Stage (Days)	20	35	40	25	---	120
	Rooting Depth (m)	0.3	---	---	1	---	---
	Crop height (m)		---	2	---	---	---

Source: FAO,2008

Table 2.3. Crop sowing windows selected for cotton and maize

District	Cotton		Maize	
	Normal Sowing	Late Sowing	Normal Sowing	Late Sowing
Warangal	Jun-20	Jul-25	Jul-10	Aug-15
Khammam	Jun-10	Jul-20	Jul-15	Aug-10
Mahaboobnagar	Jun-10	Jul-15	Jun-20	Jul-30
Rangareddy	Jun-10	Jul-20	Jun-10	Jul-15
Karimnagar	Jun-10	Jul-15	Jun-10	Jul-15
Adilabad	Jun-10	Jul-15	Jun-10	Jul-15
Nalgonda	Jul-05	Aug-10	Jun-20	Jul-25
Nizamabad	Jun-10	Jul-15	Jun-10	Jul-15
Medak	Jun-10	Jul-15	Jun-10	Jul-15

Source: Prasad et al. 2012

2.3 Estimation of crop water balance parameters

Crop water balance parameters include the effective rainfall, crop evapotranspiration and irrigation requirement were calculated using CROPWAT model. The inputs rainfall, temperature (min, max), solar radiation and crop parameters were given to CROPWAT model to calculate crop water balance parameters during crop growth period.

2.3.1 CROPWAT model

CROPWAT is a decision support tool developed by the Land and Water Development Division of FAO for calculation of crop water requirements (CWR) and irrigation requirements based on soil, climate and crop data. In addition to this, the program allows the development of irrigation schedules for different management conditions and the calculation of scheme water supply for varying crop patterns. All calculation procedures used in CROPWAT model is based on the FAO publications of the Irrigation and Drainage Series, namely, No. 56: Crop evapotranspiration -Guidelines for computing crop water requirements and No. 33: Yield response to water.

CROPWAT is a collection of modules that integrates the several models necessary to predict CWR, irrigation water management and crop scheduling (Smith, 1992). CWR represent the amount of water to be supplied and ET_c represents the amount of water that crop loses due to evapotranspiration into atmosphere. Crop water balance estimation require data on Climate (minimum and maximum temperature,^{0}C; humidity,%; wind, km/day; Sunshine, hours; and Radiation, MJ/m^2/day;) rainfall (to calculate effective rainfall), crop type and crop parameters (K_c values, Stage days, critical depletion factor, Yield response factor, crop height).

2.3.2 Reference evapotranspiration

The FAO Penman-Monteith method is used for determining reference evapotranspiration (ET_o) due to its accuracy and reliable estimate. The method has been selected because it provides very consistent estimate with actual crop water use data worldwide, as it has been demonstrated through many years in the scientific literature. This method overcomes the shortcoming of previously

recommended methods, and explicitly incorporates both physiological and aerodynamic parameters. Moreover, procedures have been developed for using this method even with limited climatic data, as used in the present study. The equation for Reference Evapotranspiration is given by:

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma(900/(T+273))U_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34\,U_2)} \quad \text{---------- (1)}$$

Where,

ET_o = Reference evapotranspiration [mm day-^{1}],

R_n = Net radiation at the crop surface [MJ m^{-2} day^{-1}],

G = Soil heat flux density [MJ m^{-2} day^{-1}],

T = Mean daily air temperature at 2 m height [°C],

U_2 = Wind speed at 2 m height [m s^{-1}],

e_s = Saturation vapour pressure [kPa],

e_a = Actual vapour pressure [kPa],

$e_s - e_a$ = Saturation vapour pressure deficit [kPa],

Δ = Slope vapour pressure curve [kPa °C^{-1}],

γ = Psychrometric constant [kPa °C^{-1}].

2.3.3 Crop evapotranspiration

The crop evapotranspiration (ET_c) is calculated by multiplying reference evapotranspiration (ET_o) with appropriate crop coefficients (K_c) at different growth stages. The first step in the CROPWAT software gives the output on decadal days (10 days interval) for the entire crop growth period. ET_c is obtained by the following equaiton:

$ET_c = K_c * ET_o$ ----------(2)

where,

ET_c = Crop evapotranspiration (mm/day),

ET_o = Reference evapotranspiration (mm/day);

K_c = Crop coefficient at a specific growth stage.

K_c depends on the type of crop (e.g., crop height, resistance of canopy, albedo), soil and climatic parameters, such as, soil surface, evaporation and wind speed and direction.

2.3.4 Effective rainfall

In assessing CWR for a crop, it is essential to understand the effective rainfall (ER) over the cultivated area. The effective rainfall can be calculated using the Soil Conservation Service method of USDA(1967). Effective rainfall is the portion of rainfall that infiltrates into the root zone during growth period of a crop and is available to meet consumptive water requirements. The effective rainfall is calculated by the following formulae:

$$P_{eff(dec)} = \frac{P_{dec} * (125 - 0.6 * P_{dec})}{125} \quad \text{if } P_{dec} <= (250 / 3) \text{ mm ----------(3)}$$

$$P_{eff(dec)} = \left(\frac{125}{3}\right) + 0.1 * P_{dec} \quad \text{if } P_{dec} > (250 / 3) \text{ mm----------(4)}$$

Where,

$P_{eff(dec)}$ = 10 days effective rainfall,

P_{dec} = 10 days rainfall

2.3.5 Irrigation requirement

The irrigation requirement (IR), expressed in mm and computed over a certain period of time, expresses the difference between the crop evapotranspiration (ET_c) under standard conditions and the effective rainfall (ER) contributions over the same time step. Irrigation requirement indicatively represents the fraction of the crop water requirements that needs to be satisfied through irrigation contributions in order to achieve optimal crop growing conditions.

2.4 Decadal averages

The year wise calculated crop water balance parameters for crop growth period during normal and late sowing periods were used to calculate the decadal averages. The average of 10 years data is called decadal average. The decadal average is calculated for 2011 to 2020, 2021 to 2030, 2031 to 2040 and 2041 to 2050.

2.5 Decadal percent deviation

Decadal percent deviation of each decade over base period (1961-1990) was calculated using the formula as given below.

$$\text{Decadal percent deviation} = \frac{\text{Decadal average value} - \text{Base period value}}{\text{Base period value}} \times 100 \quad \text{----(5)}$$

Where,

Base period = 1961-1990, Decadal average value = average of period 2011-2020(D_1), 2021-2030(D_2), 2031-2040(D_3) and 2041-2050(D_4).

2.6 Spatial maps

The base period, decadal and decadal percent deviation spatial maps of rainfall (R), effective rainfall(ER), crop evapotranspiration (ET_c) and irrigation requirement (IR) were prepared by using Arc GIS 9.3 software.

2.7 Limitations of the present study

(a) The CCAFS-MarkSim DSSAT model climate data has been compared with observed weather data of one location (GRF Station) of Ranga Reddy district due to non-availability of weather data for the base period for other districts.

(b) The present analysis is based on the downscaled ECHam5 GCM model data for A1b scenario. For changed scenario, the results may be further corroborated.

(c) Since the relationship between CO_2 concentration and its effect of evapotranspiration for various crops in the region under consideration is not available, the present study considered the medium CO_2 concentration of 445-535 ppm. Some correction factor may be devised in future when such information are available for region and crops.

(d) The time horizon in different scenario usually are 30 years period, the present study deals with the decadal changes in the different parameters of crop water balance.

3 Climate Change Impacts on Crop Water Balance of Cotton and Maize

The crop water balance parameters (rainfall, effective rainfall, crop evapotranspiration and irrigation requirement) of cotton and maize for both normal(NS) and late sowing(LS) windows of each district have been calculated using CROPWAT model. The results include for base period (BP:1961-1990), decades (D_1:2011-2020, D_2:2021-2030, D_3:2031-2040 and D_4:2041-2050) and decadal percent deviation. The number of the prepared spatial maps are given in Table.3.1.

Table 3.1. Number of spatial maps for crop water balance parameters of cotton and maize

Data Type	Sowing period	Rainfall	Effective Rainfall	Crop Evapotranspiration	Irrigation Requirement	Total
Base Period (1961-1990)	Normal	1+1	1+1	1+1	1+1	4+4
	Late	1+1	1+1	1+1	1+1	4+4
Decadal Period (D_1, D_2, D_3 and D_4)	Normal	4+4	4+4	4+4	4+4	16+16
	Late	4+4	4+4	4+4	4+4	16+16
Decadal percent deviation over base period	Normal	4+4	4+4	4+4	4+4	16+16
	Late	4+4	4+4	4+4	4+4	16+16
Total		18+18	18+18	18+18	18+18	72+72

The estimted model data on decadal average crop water balance parameters of cotton in Telangana during crop growth period is given in Table 3.2. The decadal percent deviation of crop water balance parameters of cotton with respect to base period is given in Table 3.3. The summary of climate change impacts on crop water balance of cotton is given in Table 3.4. The decadal average crop water balance parameters of maize in Telangana during crop growth period is given in Table 3.5. The decadal percent deviation of crop water balance parameters of maize with respect to base period is given in Table 3.6. The summary of climate change impacts on crop water balance of maize is given in Table 3.7.

The spatial maps of decadal average crop water balance parameters of cotton are given in Figures 3.1 to 3.40. The spatial maps of decadal average percent deviation of crop water balance of cotton are given in Figures 3.41 to 3.72. Similarly, the spatial maps of decadal average crop water balance parameters of maize are given in Figures 3.73 to 3.112. The spatial maps of decadal average percent deviation of crop water balance of maize are given in Figures 3.113 to 3.144.

Table 3.2. Decadal crop water balance of cotton in Telangana during crop growth period

A. District: WARANGAL; Crop: Cotton

Normal Sowing(NS): Jun- 20; Late Sowing(LS): Jul-25;
Crop Growth Period (CGP):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	894.50	444.40	954.08	930.20	957.28	921.38	1002.47	964.22	982.05	952.34
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	431.90	239.70	502.41	471.94	501.64	470.35	548.66	519.99	544.02	516.30
Reference	Fig.3.2	Fig.3.6	Fig.3.1	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.3	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	592.20	581.90	584.25	489.83	586.55	492.57	583.19	490.81	584.91	491.20
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	348.80	438.50	172.26	206.58	170.88	210.32	136.67	173.39	130.71	167.51
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.2	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.4

B. District: KHAMMAM; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-20;
Crop Growth Period (CGP):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	1027.90	516.40	1206.17	1041.14	1151.46	1000.85	1124.45	992.79	1159.26	1018.82
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	535.20	320.20	598.84	479.55	600.31	480.67	607.63	500.16	624.69	517.60
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	626.50	605.80	611.87	528.82	614.08	531.20	618.70	533.72	625.14	535.43
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	283.10	416.20	140.60	230.18	125.14	222.74	106.14	204.87	102.36	191.44
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

C. District: MAHBUBNAGAR; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	868	434.10	745.05	688.11	797.81	735.01	776.12	716.23	765.13	719.69
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	448.80	267.70	458.47	415.50	481.30	434.56	488.83	444.11	483.99	448.76
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	638.10	608.20	654.46	539.74	654.74	539.28	658.46	542.58	663.25	544.94
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	353.50	437.90	240.90	234.31	222.52	216.46	212.89	203.93	217.22	201.04
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

D. District: RANGAREDDY; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-20;
Crop Growth Period (CGPt):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	1015.80	570.70	879.72	869.20	889.87	873.78	890.53	887.54	891.50	875.62
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	528.70	323.30	504.76	494.27	522.11	507.05	524.74	520.65	535.53	520.11
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	603.80	579.70	639.72	523.12	613.17	502.05	541.31	445.11	544.82	446.89
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	260.70	381	184.28	162.62	155.73	147.19	123.03	112.91	108.34	109.56
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

E. District: KARIMNAGAR; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	784.80	357.20	962.44	978.38	942.52	955.56	898.79	908.16	728.89	938.16
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	413.50	243.60	503.05	518.68	508.70	523.61	499.33	508.51	513.22	529.45
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	610	599.40	645.48	532.98	640.46	528.43	634.99	531.91	653.21	536.03
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	367.50	452.80	187.74	145.44	186.43	136.29	199.69	149.95	198.46	134.84
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

F. District: ADILABAD; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	953.10	470.20	995.93	997.86	984.18	987.87	991.86	991.53	992.99	992.79
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	453.90	263.20	524.46	529.59	513.22	517.01	518.80	518.88	519.93	519.54
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	624	608	671.87	554.27	678.56	558.51	682.9	560.72	687.26	562.75
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	361.80	468.80	192.61	162.05	200.32	176.50	206.86	178.91	214.21	184.71
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

G. District: NALGONDA; Crop: Cotton

Normal Sowing(NS): Jul-05; Late Sowing(LS):Aug-10;
Crop Growth Period (CGP):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	453.60	223.40	708.77	619.77	703.34	647.16	705.11	651.37	692.62	655.30
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	296.10	166.30	441.02	374.64	452.54	403.95	454.77	410.06	462.13	429.59
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	618.80	602	594.68	535.61	595.25	536.68	596.96	542.16	598.87	545.27
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	413.90	478.40	231.99	285.49	216.86	258.97	216.52	257.42	210.81	253.59
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

H. District: NIZAMABAD; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	1168.40	646.50	1137.95	1117.44	1120.07	1099.10	1115.90	1106.10	1042.85	1045.02
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	579.70	386.70	558.42	550.45	556.99	549.49	560.57	558.88	553.06	563.87
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	612.20	606.50	649.91	544.20	652.53	547.82	654.43	549.29	655.59	547.84
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	233.60	383.90	173.35	175.45	171.49	173.59	168.27	166.97	170.96	143.62
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

I. District: MEDAK; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	1103.20	625.30	949.29	930.85	929.04	910.12	941.81	921.86	951.81	931.24
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	516.60	326.10	511.97	498.71	505.17	490.66	528.46	511.25	545.1	527.84
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	603.90	593	643.91	533.12	647.41	535.24	650.16	537.37	654.99	540.61
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	302.30	423.70	176.02	168.52	185.09	176.30	165.58	159.21	161.27	150.76
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

Table 3.3. Decadal percent deviation of crop water balance of cotton from base period (1961-1990) in Telangana

A. District: WARANGAL; Crop: Cotton

Normal Sowing(NS): Jun- 20; Late Sowing(LS): Jul-25;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	6.66	109.32	7.02	107.33	12.07	116.97	9.79	114.30
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	16.33	96.89	16.15	96.22	27.03	116.93	25.96	115.39
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	-1.54	-15.82	-1.95	-15.35	-1.52	-15.65	-1.53	-15.59
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-50.61	-52.49	-51.01	-52.04	-60.82	-60.56	-62.53	-61.50
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

B. District: KHAMMAM; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-20;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	17.34	101.62	12.02	93.81	9.39	92.25	12.78	97.29
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	11.89	49.77	12.17	51.12	13.53	56.20	16.72	61.65
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	-2.34	-12.71	-1.98	-12.31	-1.25	-11.90	-0.22	-11.62
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-50.34	-44.69	-55.80	-46.48	-62.51	-50.78	-63.84	-54.00
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

C. District: MAHBUBNAGAR; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	-14.16	58.51	-8.09	69.32	-10.59	64.99	-11.85	65.79
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	2.15	55.21	7.24	62.33	8.92	65.90	7.84	67.64
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	2.56	-11.26	2.61	-11.33	3.19	-10.82	3.94	-10.40
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-31.85	-46.49	-37.05	-50.57	-39.78	-53.43	-38.55	-54.09
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

D. District: RANGAREDDY; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-20;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	-13.40	52.30	-12.40	53.11	-12.33	55.52	-12.24	53.43
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-4.53	52.88	-1.25	56.84	-0.75	61.54	1.29	61.88
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	5.95	-9.56	1.55	-13.39	-10.35	-23.22	-9.47	-22.91
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-29.31	-57.32	-40.26	-61.37	-52.41	-70.36	-58.44	-71.24
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

E. District: KARIMNAGAR; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	22.64	173.90	20.10	167.51	14.52	154.24	-7.12	162.64
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	21.66	112.92	23.02	114.95	20.76	108.75	24.12	117.34
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	5.82	-11.08	4.99	-11.84	4.10	-11.26	7.08	-10.57
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-48.91	-67.88	-49.27	-69.90	-45.66	-66.88	-46.00	-70.22
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

F. District: ADILABAD; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	4.49	112.22	3.26	110.96	4.07	110.87	4.19	111.14
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	15.55	101.21	13.07	96.43	14.30	97.14	14.55	97.39
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	7.67	-9.84	8.74	-8.14	9.44	-7.78	10.14	-7.44
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-46.76	-65.43	-44.63	-62.35	-42.82	-61.84	-40.79	-61.60
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

G. District: NALGONDA; Crop: Cotton

Normal Sowing(NS): Jul-05; Late Sowing(LS):Aug-10;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	56.25	177.43	55.06	189.69	55.45	191.57	52.69	193.33
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	48.94	125.28	52.83	142.90	53.59	146.58	56.07	158.32
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	-3.90	-11.03	-3.81	-10.85	-3.53	-9.94	-3.22	-9.42
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-43.45	-40.32	-47.61	-45.87	-47.69	-46.19	-49.07	-47.05
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

H. District: NIZAMABAD; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	-2.61	72.84	-4.14	70.01	-4.49	71.09	-10.75	61.64
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-3.67	42.35	-3.92	42.10	-3.30	44.53	-4.60	45.82
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	6.16	-10.27	6.59	-9.48	6.90	-9.43	7.09	-9.47
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-25.79	-54.30	-26.59	-54.78	-27.97	-56.51	-26.82	-62.59
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

I. District: MEDAK; Crop: Cotton

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):180 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	-13.95	48.86	-15.79	45.55	-14.63	47.43	-13.72	48.93
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-0.90	52.93	-2.21	51.46	2.30	56.78	5.52	61.86
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	6.63	-10.10	7.20	-9.44	7.66	-9.38	8.46	-8.83
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-41.77	-60.23	-38.77	-58.39	-45.23	-62.42	-46.65	-64.42
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

Table 3.4. Summary of climate change impacts on crop water balance of cotton in Telangana

District	Rainfall		Effective Rainfall		Crop ET		Irrigation requirement	
	NS	LS	NS	LS	NS	LS	NS	LS
Warangal	↑	↑	↑	↑	↓	↓	↓	↓
Khammam	↑	↑	↑	↑	↓	↓	↓	↓
Mahaboobnagar	↓	↑	↑	↑	↑	↓	↓	↓
Rangareddy	↓	↑	↓	↑	↓	↓	↓	↓
Karimnagar	↑	↑	↑	↑	↑	↓	↓	↓
Adilabad	↑	↑	↑	↑	↑	↓	↓	↓
Nalgonda	↑	↑	↑	↑	↓	↓	↓	↓
Nizamabad	↓	↑	↓	↑	↑	↓	↓	↓
Medak	↓	↑	↑	↑	↑	↓	↓	↓

Note:↑- Increase over base period; ↓ - Decrease over base period; NS - Normal sowing; LS - Late sowing

Table 3.5. Decadal crop water balance of maize in Telangana during crop growth period

A. District: WARANGAL; Crop: Maize

Normal Sowing(NS): Jul- 10; Late Sowing(LS): Aug-15;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	541.60	253.70	911.87	689.89	908.13	700.08	896.35	771.44	877.32	745.97
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	284.60	152.30	456.29	335.12	452.13	340.33	459.15	396.36	454.12	394.48
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotranspiration (ETc)	381.10	380.40	437.69	319.5	438.11	316.88	434.93	311.30	437.12	313.88
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	222.60	275.20	110.46	130.33	111.83	123.30	106.87	82.01	100.56	78.59
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

B. District: KHAMMAM; Crop: Maize

Normal Sowing(NS): Jul-15; Late Sowing(LS):Aug-10;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	545.20	284.60	1049.12	711.21	1016.95	712.89	1000.66	699.66	1024.64	737.75
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	327.80	215.30	478.81	347.03	485.03	362.59	495.71	380.7	505.06	395.19
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	399.80	391.20	387.78	317.81	388.95	317.40	392.37	318.54	398.90	320.78
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	188.70	247.30	90.96	118.14	77.09	96.46	65.00	77.88	65.40	72.30
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

C. District: MAHBUBNAGAR; Crop: Maize

Normal Sowing(NS): Jun-20; Late Sowing(LS):Jul-30;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	765.50	242	600.59	651.80	634.06	698.55	591.23	679.71	565.68	669.19
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	362.50	189.20	358.04	375.55	365.51	396.48	356.32	406.62	343.26	398.93
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	419.90	402.50	519.34	392.85	521.72	391.19	524.93	393.44	529.52	396.13
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	201.70	262.80	191.47	139.79	191.45	118.54	197.49	114.44	204.23	124.17
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

D. District: RANGAREDDY; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	972.10	548.10	661.53	794.60	656.98	811.51	657.53	809.70	665.93	800.91
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	487.20	325.20	350.51	428.35	358.42	446.41	355.70	447.94	367.16	449.48
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	398.80	385.60	515.22	414.59	495.62	396.48	438.86	349.4	443.06	352.55
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	81.90	170.10	183.87	78.38	164.36	63.44	123.88	45.39	108.14	44.16
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

E. District: KARIMNAGAR; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	752.20	333.10	766.47	908.26	732.91	874.15	674.90	816.36	695.53	844.89
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	386.30	221	365.29	448.45	358.47	452.82	340.77	434.14	352.03	449.60
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	388.60	386.10	521.43	417.09	517.51	414.15	522.98	418.54	529.01	423.18
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	151.20	249.10	175.05	61.63	176.21	63.79	193.17	81.46	193.31	73.83
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

F. District: ADILABAD; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	929.20	452.50	771.76	967.43	759.43	958.33	747.63	963.58	786.89	1016.89
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	434.60	246.60	384.75	486.95	376.85	479.81	375.04	483.58	399.66	503.80
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	399.20	393.10	547.38	436.32	552.35	440.98	557.18	443.94	563.11	447.11
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	129.10	256.50	181.99	73.06	185.86	84.45	194.18	84.61	185.23	75.57
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

G. District: NALGONDA; Crop: Maize

Normal Sowing(NS): Jun-20; Late Sowing(LS):Jul-25;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	542.90	264.30	575.71	652.34	540.77	664.13	490.48	664.45	416.48	653.77
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	322.80	196.60	353.85	385.66	337.40	412.08	326.07	411.15	301.41	413.00
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	419.30	407.40	518.55	405.26	519.4	403.93	527.98	404.56	536.50	406.62
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	196.30	261	182.84	137.57	199.90	120.58	219.26	120.35	246.96	119.99
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

H. District: NIZAMABAD; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	1134.60	627.30	812.01	1068.99	814.92	1036.21	816.27	1038.9	776.66	975.59
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	547.40	369.30	398.39	506.02	390.46	494.69	390.81	500.68	376.86	500.96
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	388.50	387.90	533.65	418.13	530.94	415.77	532.73	416.43	536.01	414.64
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	33	146	155.59	76.50	157.42	78.82	160.68	78.54	179.07	57.43
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

I. District: MEDAK; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	BP		Decadal average of crop water balance, mm							
			D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	1080 .10	613.90	738.37	895.54	723.16	870.16	713.97	884.78	687.48	893.62
Reference	Fig.3.1	Fig.3.5	Fig.3.9	Fig.3.13	Fig.3.17	Fig.3.21	Fig.3.25	Fig.3.29	Fig.3.33	Fig.3.37
Effective Rainfall (ER)	494.40	315.30	384.17	457.99	384.83	451.68	390.69	470.81	393.18	484.84
Reference	Fig.3.2	Fig.3.6	Fig.3.10	Fig.3.14	Fig.3.18	Fig.3.22	Fig.3.26	Fig.3.30	Fig.3.34	Fig.3.38
Crop Evapotran-spiration (ETc)	388	385.50	523.24	428.89	526.21	429.81	529.99	430.35	520.28	421.27
Reference	Fig.3.3	Fig.3.7	Fig.3.11	Fig.3.15	Fig.3.19	Fig.3.23	Fig.3.27	Fig.3.31	Fig.3.35	Fig.3.39
Irrigation Requirement (IR)	82.50	199.40	152.78	79.66	158.64	80.60	158.44	67.93	149.27	61.38
Reference	Fig.3.4	Fig.3.8	Fig.3.12	Fig.3.16	Fig.3.20	Fig.3.24	Fig.3.28	Fig.3.32	Fig.3.36	Fig.3.40

BP: Base Period (1961-1990); D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

Table 3.6. Decadal percent deviation of crop water balance of maize from base period (1961-1990) in Telangana

A. District: WARANGAL; Crop: Maize

Normal Sowing(NS): Jul- 10; Late Sowing(LS): Aug-15;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	68.37	171.93	67.68	175.95	65.50	204.08	61.99	194.04
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	60.33	120.04	58.87	123.46	61.33	160.25	59.56	159.02
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	14.85	-16.01	14.96	-16.70	14.12	-18.17	14.70	-17.49
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-50.38	-52.64	-49.76	-55.20	-51.99	-70.60	-54.87	-71.44
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

B. District: KHAMMAM; Crop: Maize

Normal Sowing(NS): Jul-15; Late Sowing(LS):Aug-10;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	92.43	149.90	86.53	150.59	83.54	145.84	87.94	159.22
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	46.07	61.18	47.97	68.41	51.22	76.82	54.08	83.55
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	-3.01	-18.55	-2.71	-18.66	-1.86	-18.36	-0.23	-17.79
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-51.80	-52.23	-59.15	-60.99	-65.55	-68.51	-65.34	-70.76
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

C. District: MAHBUBNAGAR; Crop: Maize

Normal Sowing(NS): Jun-20; Late Sowing(LS):Jul-30;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	-21.54	169.34	-17.17	188.66	-22.77	180.87	-26.10	176.52
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-1.23	98.49	0.83	109.56	-1.70	114.92	-5.31	110.85
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	23.68	-2.40	24.25	-2.81	25.01	-2.25	26.11	-1.58
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-5.07	-46.81	-5.08	-54.89	-2.09	-56.45	1.25	-52.75
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D. District: RANGAREDDY; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	-31.95	44.97	-32.42	48.06	-32.36	47.73	-31.50	46.12
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-28.06	31.72	-26.43	37.27	-26.99	37.74	-24.64	38.22
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	29.59	7.52	24.28	2.82	10.05	-9.39	11.10	-8.57
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	124.51	-53.92	100.68	-62.70	51.26	-73.32	32.04	-74.04
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

E. District: KARIMNAGAR; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	1.90	172.67	-2.56	162.43	-10.28	145.08	-7.53	153.64
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-5.44	102.92	-7.20	104.90	-11.79	96.44	-8.87	103.44
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	34.18	8.03	33.17	7.26	34.58	8.40	36.13	9.60
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	15.77	-75.26	16.54	-74.39	27.76	-67.30	27.85	-70.36
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

F. District: ADILABAD; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	-16.94	113.80	-18.27	111.79	-19.54	112.95	-15.32	124.73
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-11.47	97.47	-13.29	94.57	-13.70	96.10	-8.04	104.30
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	37.12	10.99	38.36	12.18	39.57	12.93	41.06	13.74
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	40.97	-71.52	43.97	-67.08	50.41	-67.01	43.48	-70.54
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

G. District: NALGONDA; Crop: Maize

Normal Sowing(NS): Jun-20; Late Sowing(LS):Jul-25;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	6.04	146.82	-0.39	151.28	-9.66	151.40	-23.29	147.36
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	9.62	96.16	4.52	109.60	1.01	109.13	-6.63	110.07
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	23.67	-0.53	23.87	-0.85	25.92	-0.70	27.95	-0.19
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	-6.86	-47.29	1.83	-53.84	11.70	-53.89	25.81	-54.03
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

H. District: NIZAMABAD; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall(R)	-28.43	70.41	-28.18	65.19	-28.06	65.61	-31.55	55.52
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-27.22	37.02	-28.67	33.95	-28.70	35.58	-31.15	35.65
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	37.36	7.79	36.66	7.18	37.12	7.35	37.97	6.89
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	371.48	-47.60	377.03	-46.01	386.91	-46.21	442.64	-60.66
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

I. District: MEDAK; Crop: Maize

Normal Sowing(NS): Jun-10; Late Sowing(LS):Jul-15;
Crop Growth Period (CGP):120 days

Parameter	Percent decadal deviation from BP, %							
	D_1		D_2		D_3		D_4	
	NS	LS	NS	LS	NS	LS	NS	LS
Rainfall (R)	-31.64	45.88	-33.05	41.74	-33.90	44.12	-36.35	45.56
Reference	Fig.3.41	Fig.3.45	Fig.3.49	Fig.3.53	Fig.3.57	Fig.3.61	Fig.3.65	Fig.3.69
Effective Rainfall (ER)	-22.30	45.26	-22.16	43.25	-20.98	49.32	-20.47	53.77
Reference	Fig.3.42	Fig.3.46	Fig.3.50	Fig.3.54	Fig.3.58	Fig.3.62	Fig.3.66	Fig.3.70
Crop Evapotranspiration (ETc)	34.86	11.26	35.62	11.49	36.60	11.63	34.09	9.28
Reference	Fig.3.43	Fig.3.47	Fig.3.51	Fig.3.55	Fig.3.59	Fig.3.63	Fig.3.67	Fig.3.71
Irrigation Requirement (IR)	85.19	-60.17	92.29	-59.70	92.05	-66.04	80.93	-69.31
Reference	Fig.3.44	Fig.3.48	Fig.3.52	Fig.3.56	Fig.3.60	Fig.3.64	Fig.3.68	Fig.3.72

D_1: 2011-2020; D_2: 2021-2030; D_3:2031-2040; D_4:2041-2050

Table 3.7. Summary of climate change impacts on crop water balance of maize in Telangana

District	Rainfall		Effective Rainfall		Crop ET		Irrigation requirement	
	NS	LS	NS	LS	NS	LS	NS	LS
Warangal	↑	↑	↑	↑	↑	↓	↓	↓
Khammam	↑	↑	↑	↑	↓	↓	↓	↓
Mahaboobnagar	↓	↑	↓	↑	↑	↓	↑	↓
Rangareddy	↓	↑	↓	↑	↑	↑	↑	↓
Karimnagar	↓	↑	↓	↑	↑	↑	↑	↓
Adilabad	↓	↑	↓	↑	↑	↑	↑	↓
Nalgonda	↓	↑	↓	↑	↑	↓	↑	↓
Nizamabad	↓	↑	↓	↑	↑	↑	↑	↓
Medak	↓	↑	↓	↑	↑	↑	↑	↓

Note:↑- Increase over base period; ↓ - Decrease over base period; NS - Normal sowing; LS - Late sowing

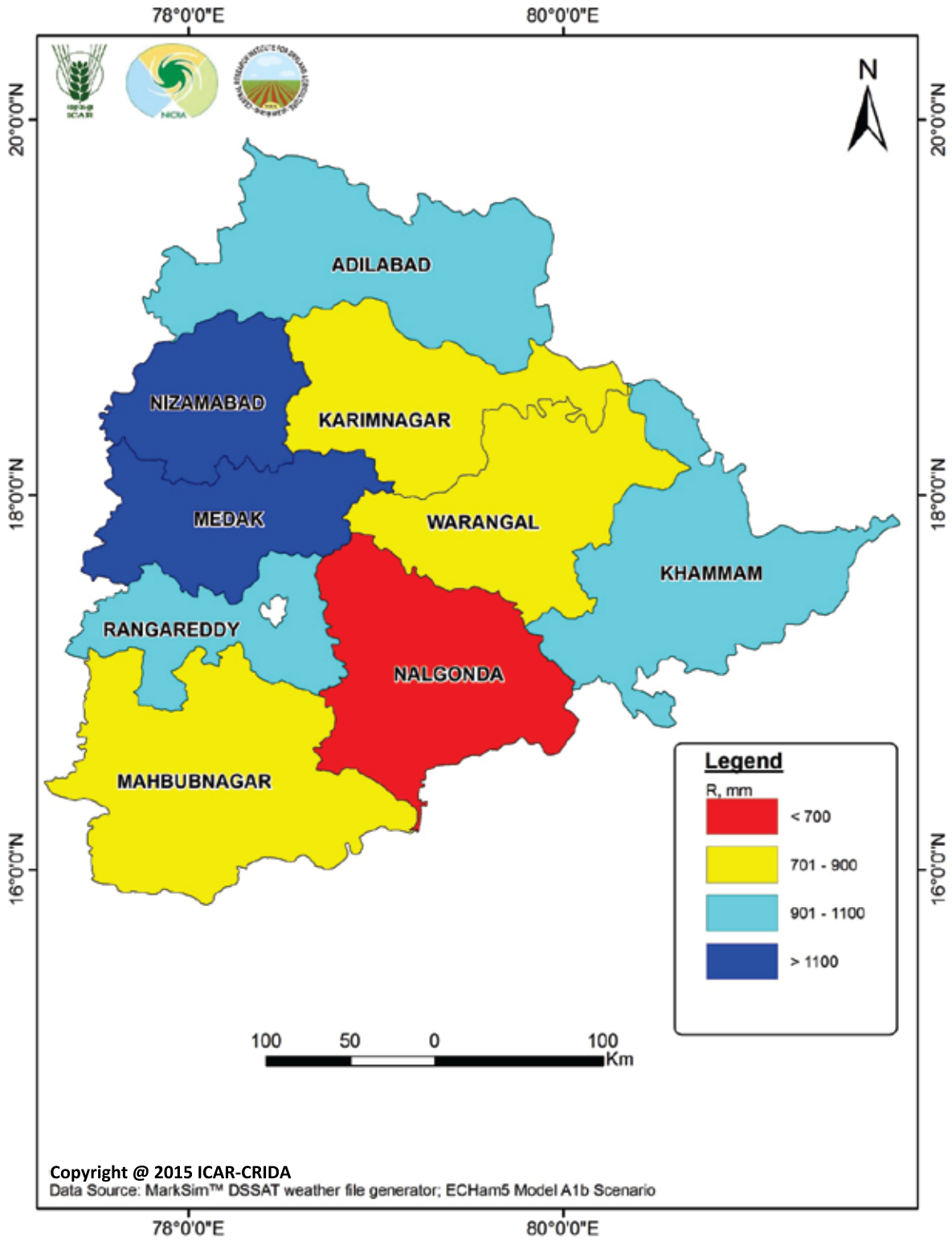

Fig.3.1 Rainfall (R) during crop growth period of cotton under normal sowing for the base period (1961-1990) in Telangana

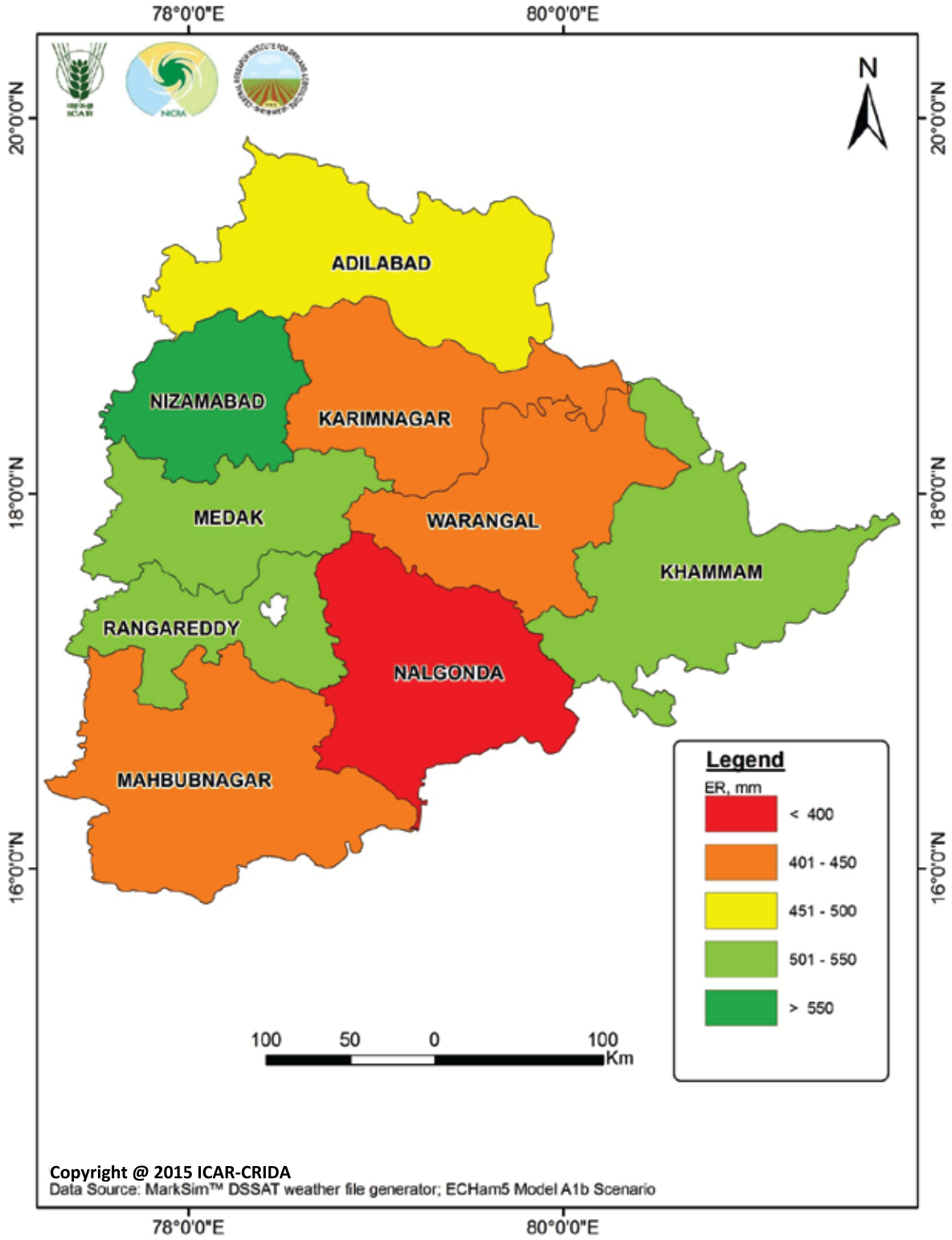

Fig.3.2 Effective rainfall (ER) during crop growth period of cotton under normal sowing for the base period (1961-1990) in Telangana

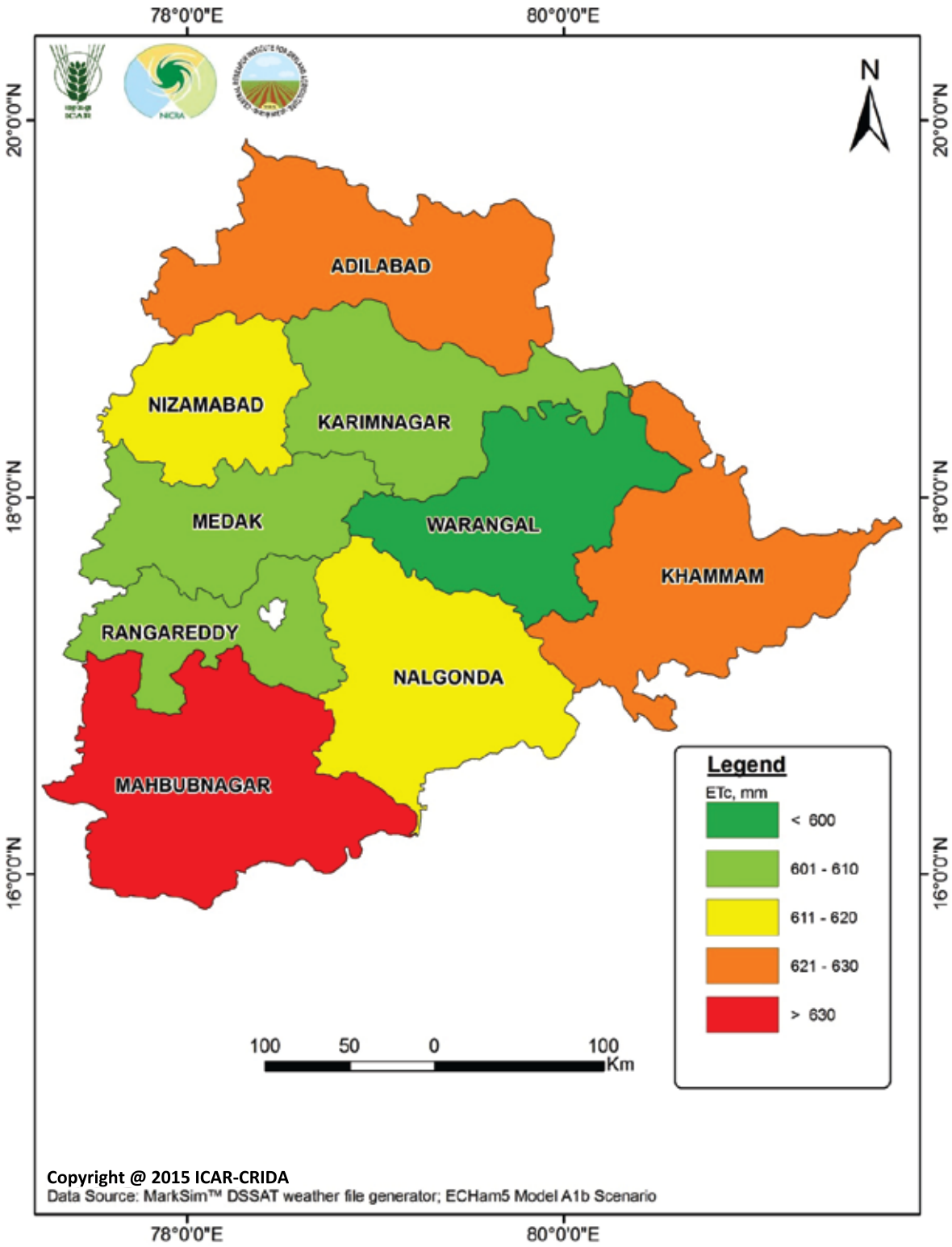

Fig.3.3 Crop evapotranspiration (ETc) during crop growth period of cotton under normal sowing for the base period (1961-1990) in Telangana

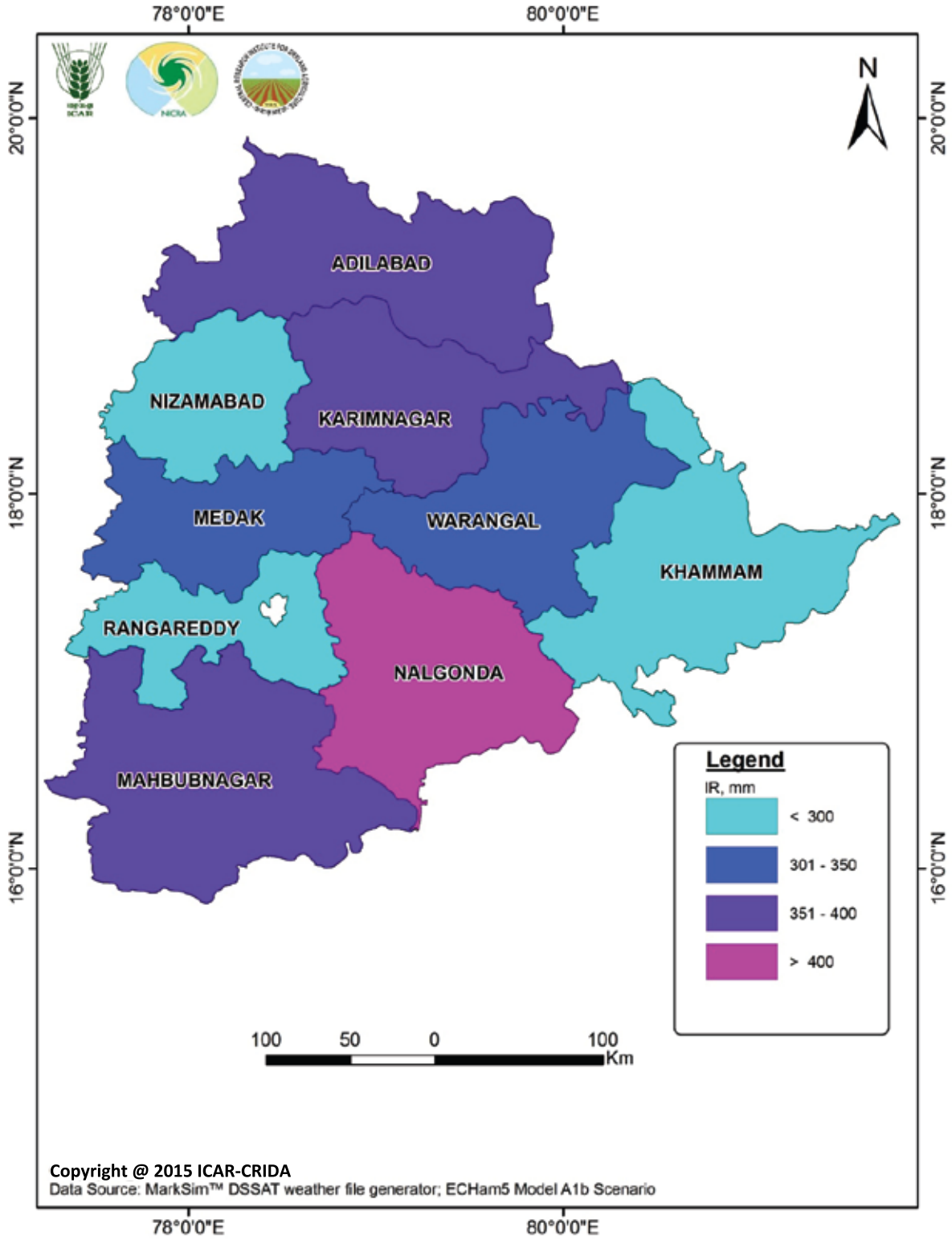

Fig.3.4 Irrigation requirement (IR) during crop growth period of cotton under normal sowing for the base period (1961-1990) in Telangana

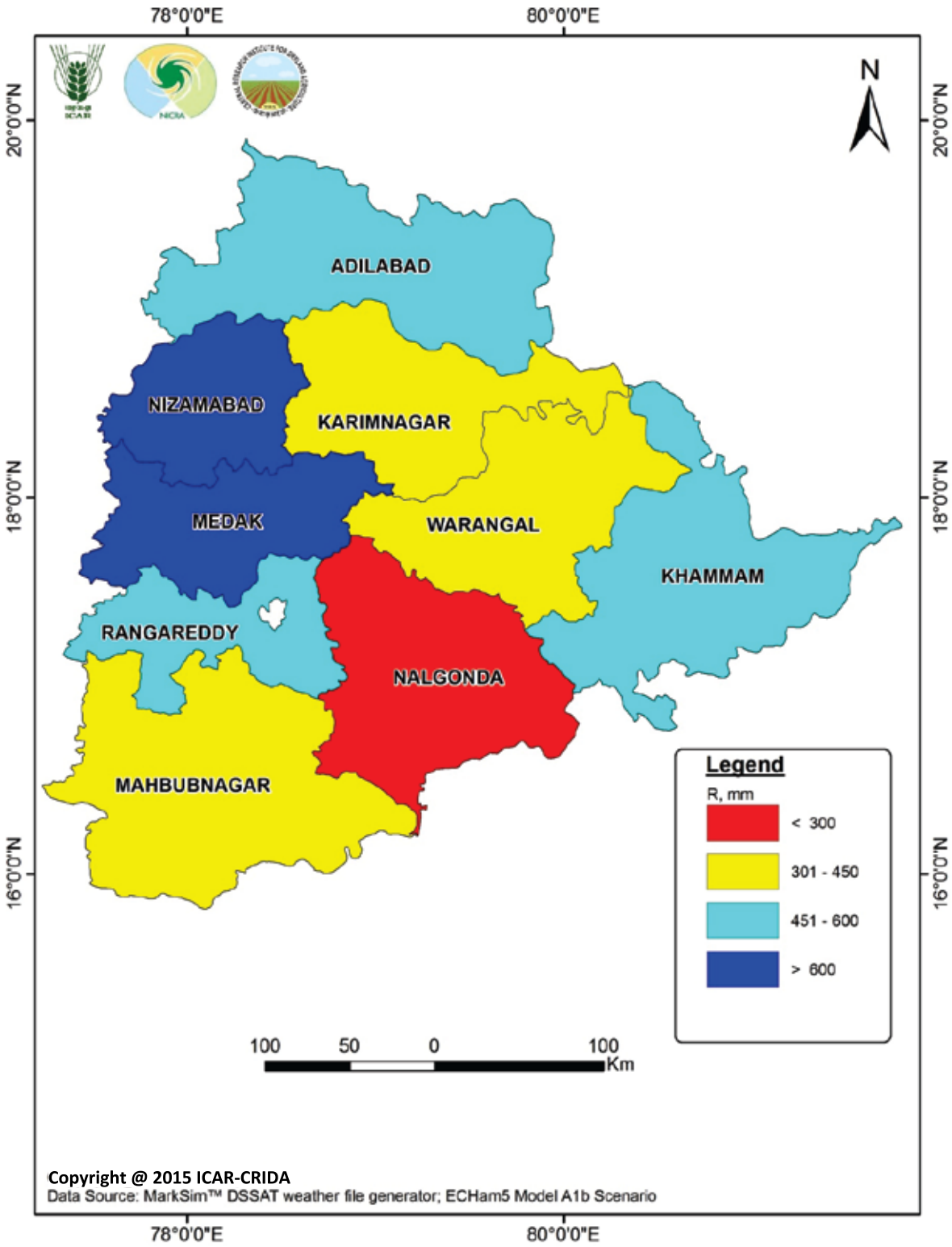

Fig.3.5 Rainfall (R) during crop growth period of cotton under late sowing for the base period (1961-1990) in Telangana

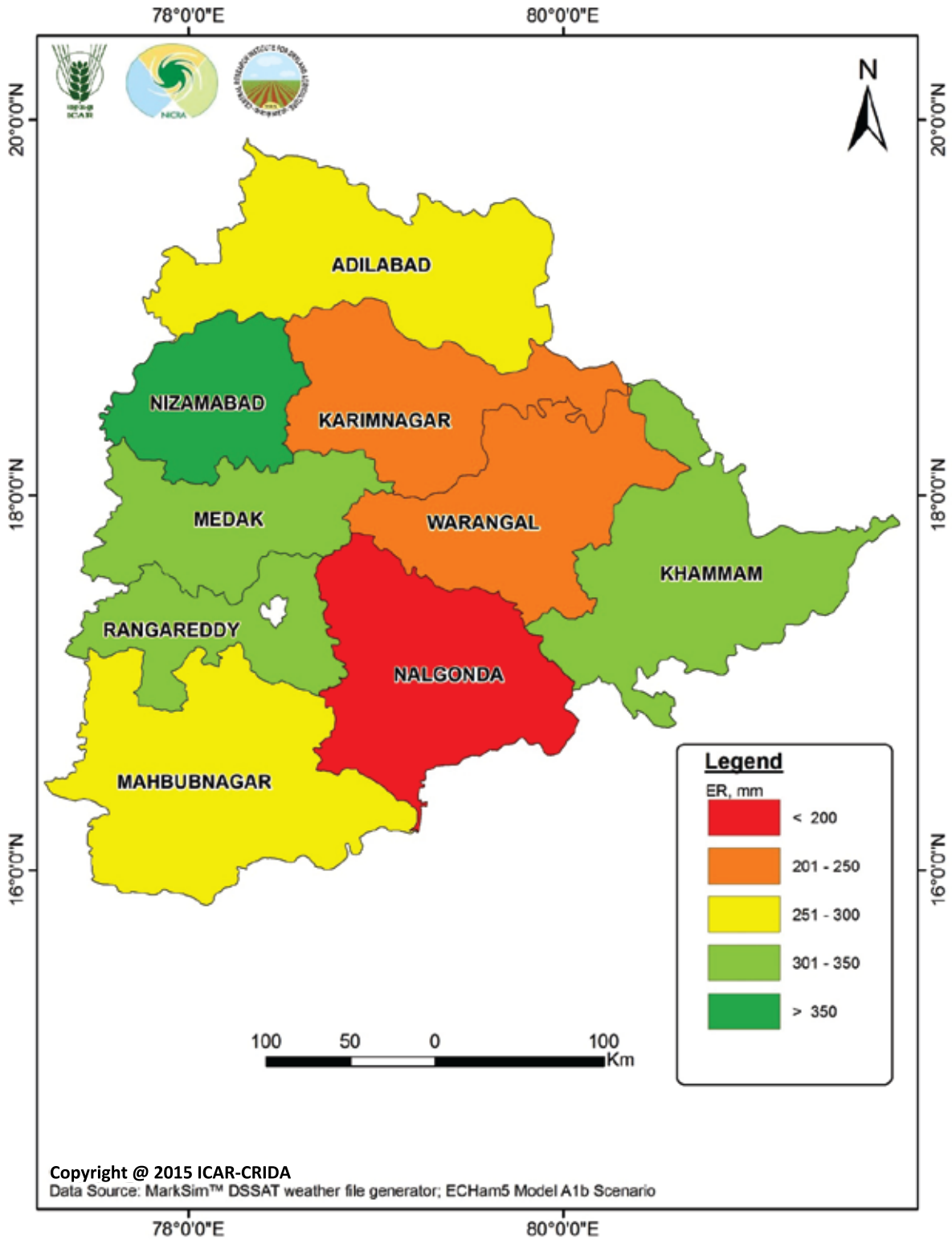

Fig.3.6 Effective rainfall (ER) during crop growth period of cotton under late sowing for the base period (1961-1990) in Telangana

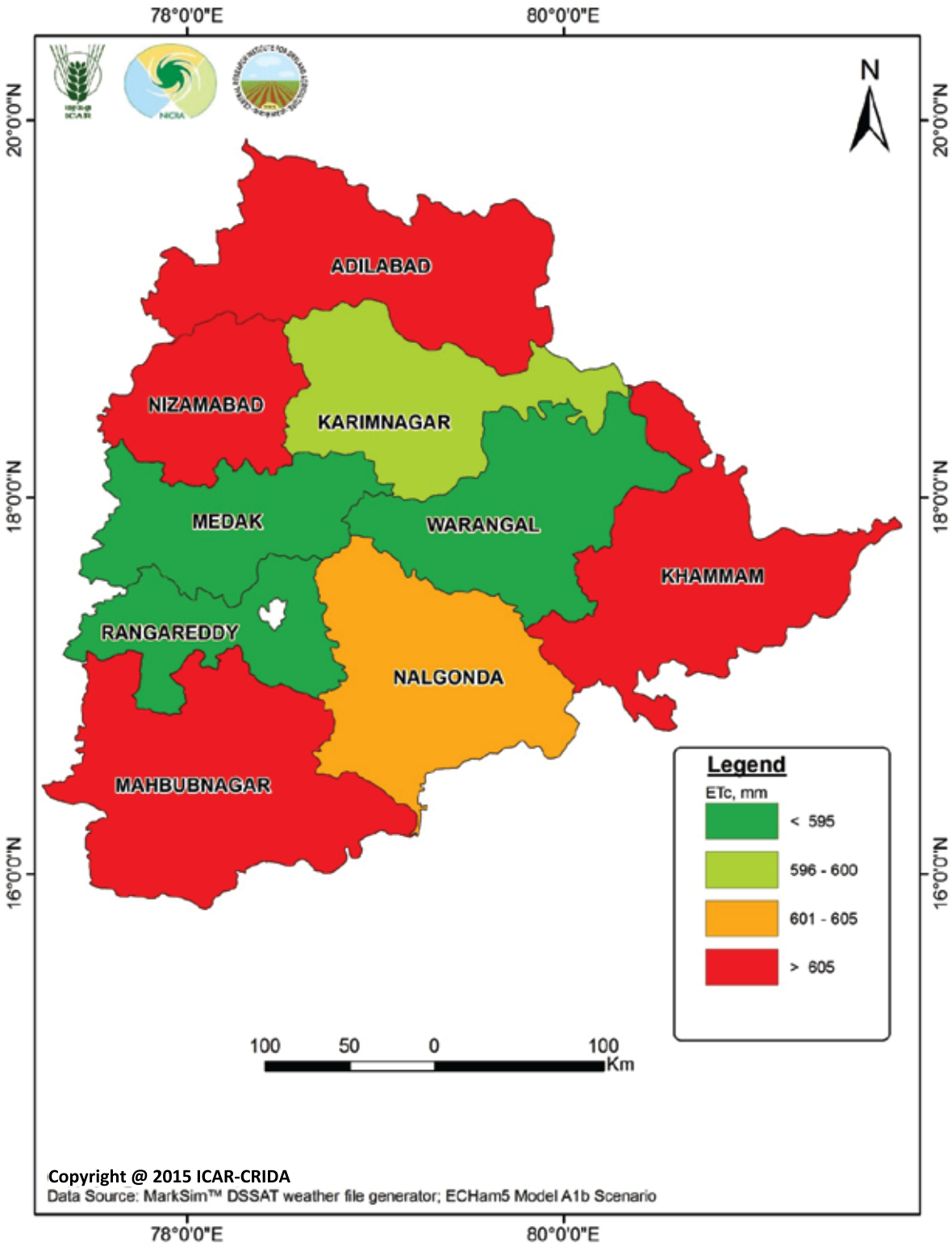

Fig.3.7 Crop evapotranspiration (ETc) during crop growth period of cotton under late sowing for the base period (1961-1990) in Telangana

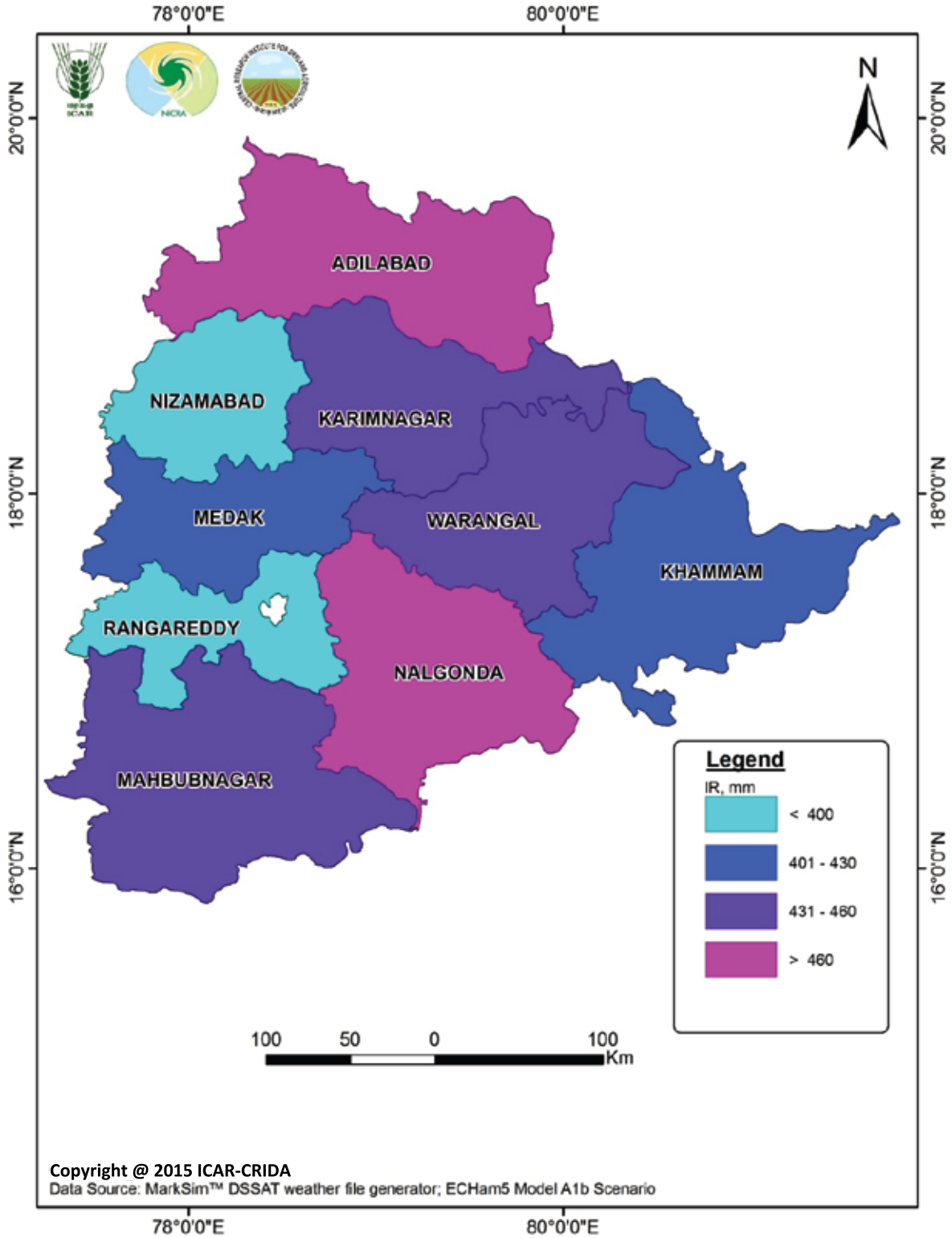

Fig.3.8 Irrigation requirement (IR) during crop growth period of cotton under late sowing for the base period (1961-1990) in Telangana

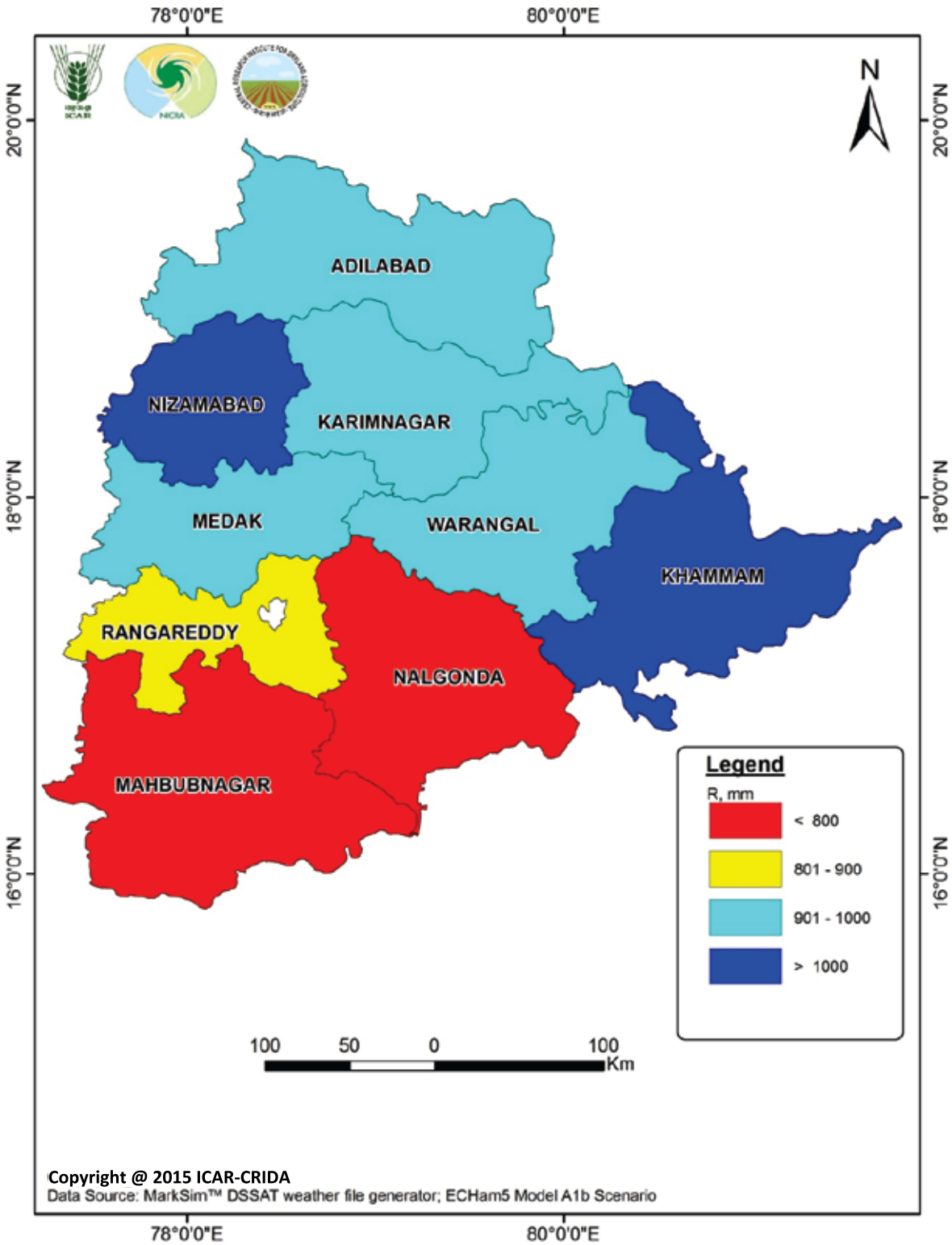

Fig.3.9 Rainfall (R) during crop growth period of cotton under normal sowing for the decade 2011-2020 in Telangana

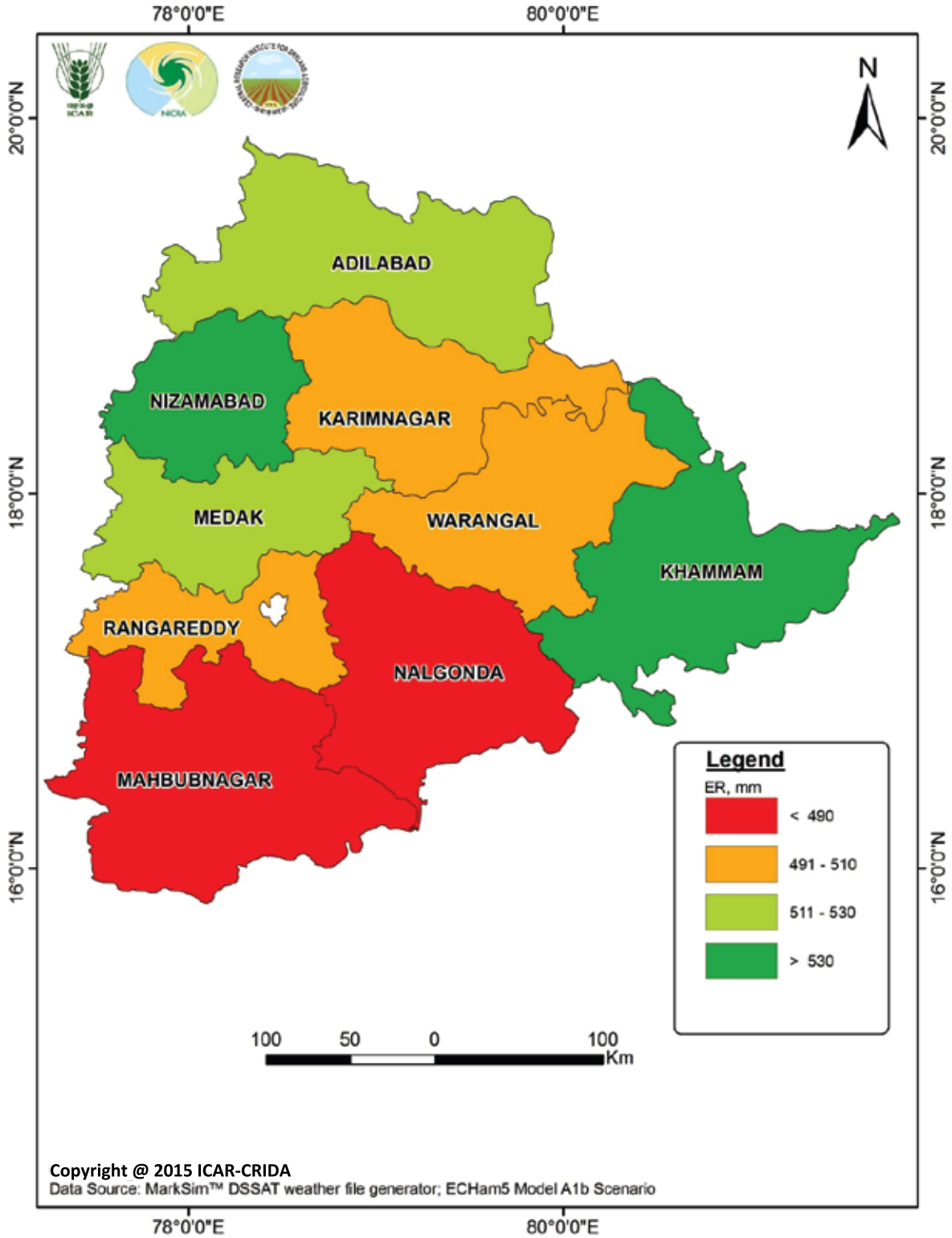

Fig.3.10 Effective rainfall (ER) during crop growth period of cotton under normal sowing for the decade 2011-2020 in Telangana

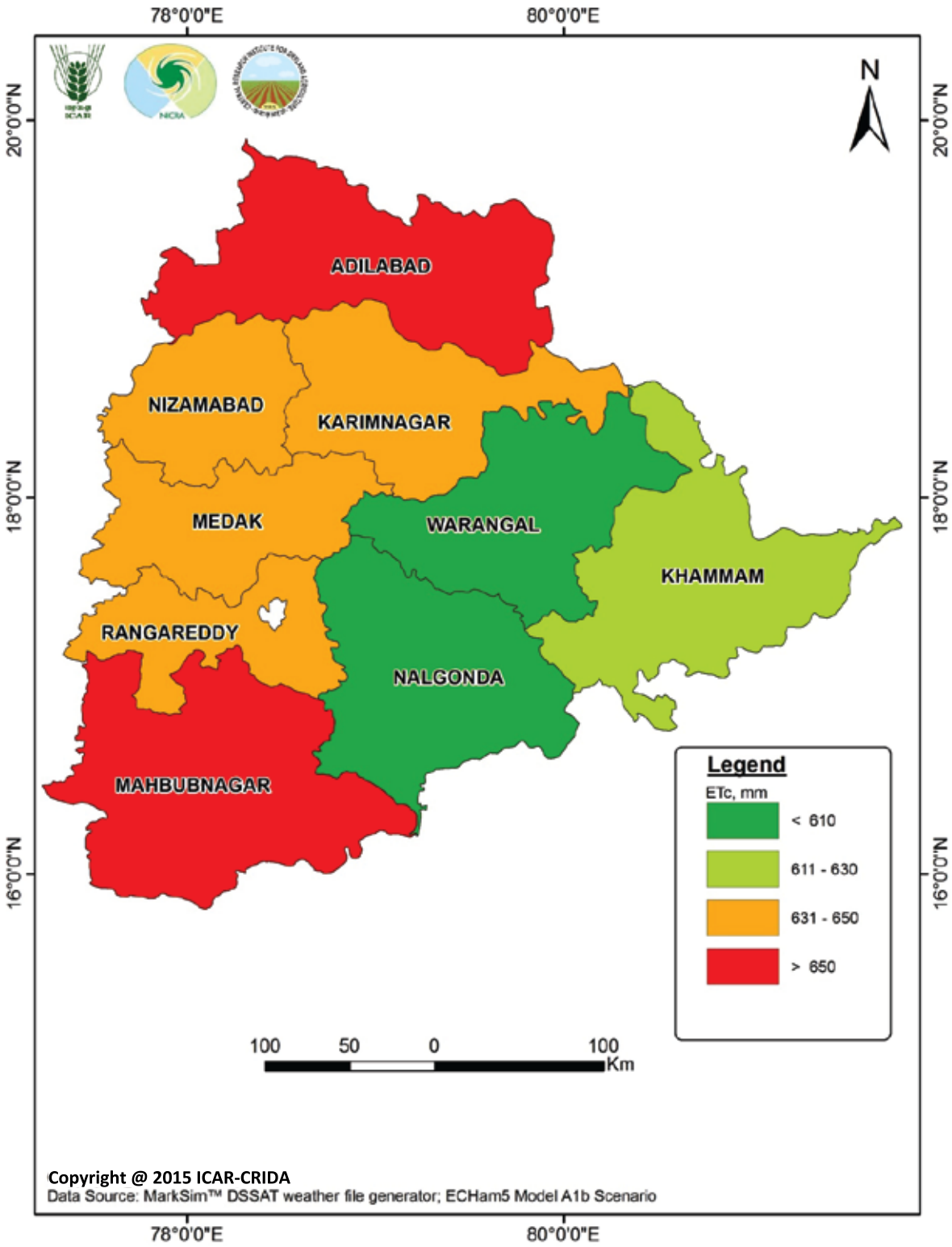

Fig.3.11 Crop evapotranspiration (ETc) during crop growth period of cotton under normal sowing for the decade 2011-2020 in Telangana

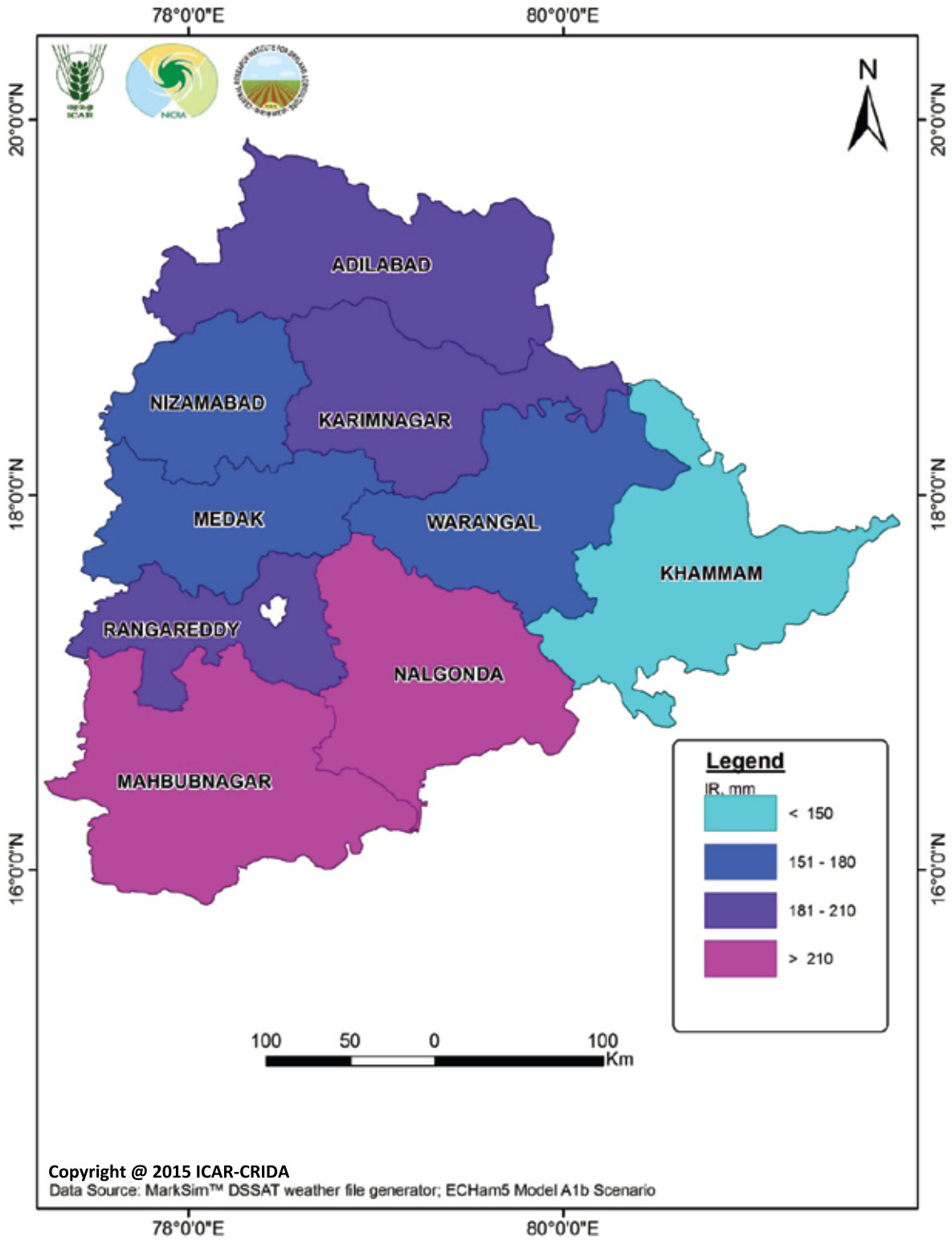

Fig.3.12 Irrigation requirement (IR) during crop growth period of cotton under normal sowing for the decade 2011-2020 in Telangana

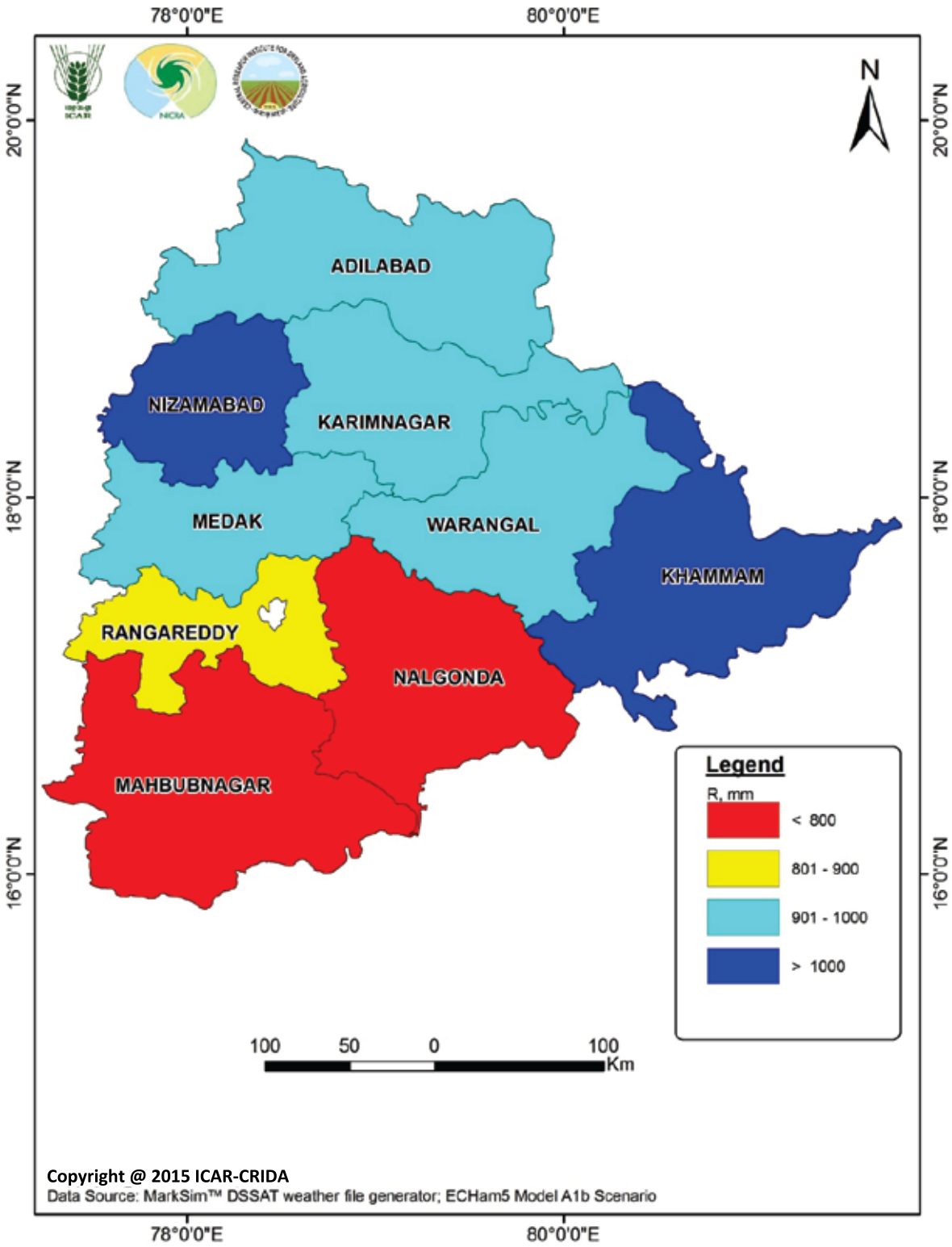

Fig.3.13 Rainfall (R) during crop growth period of cotton under late sowing for the decade 2011-2020 in Telangana

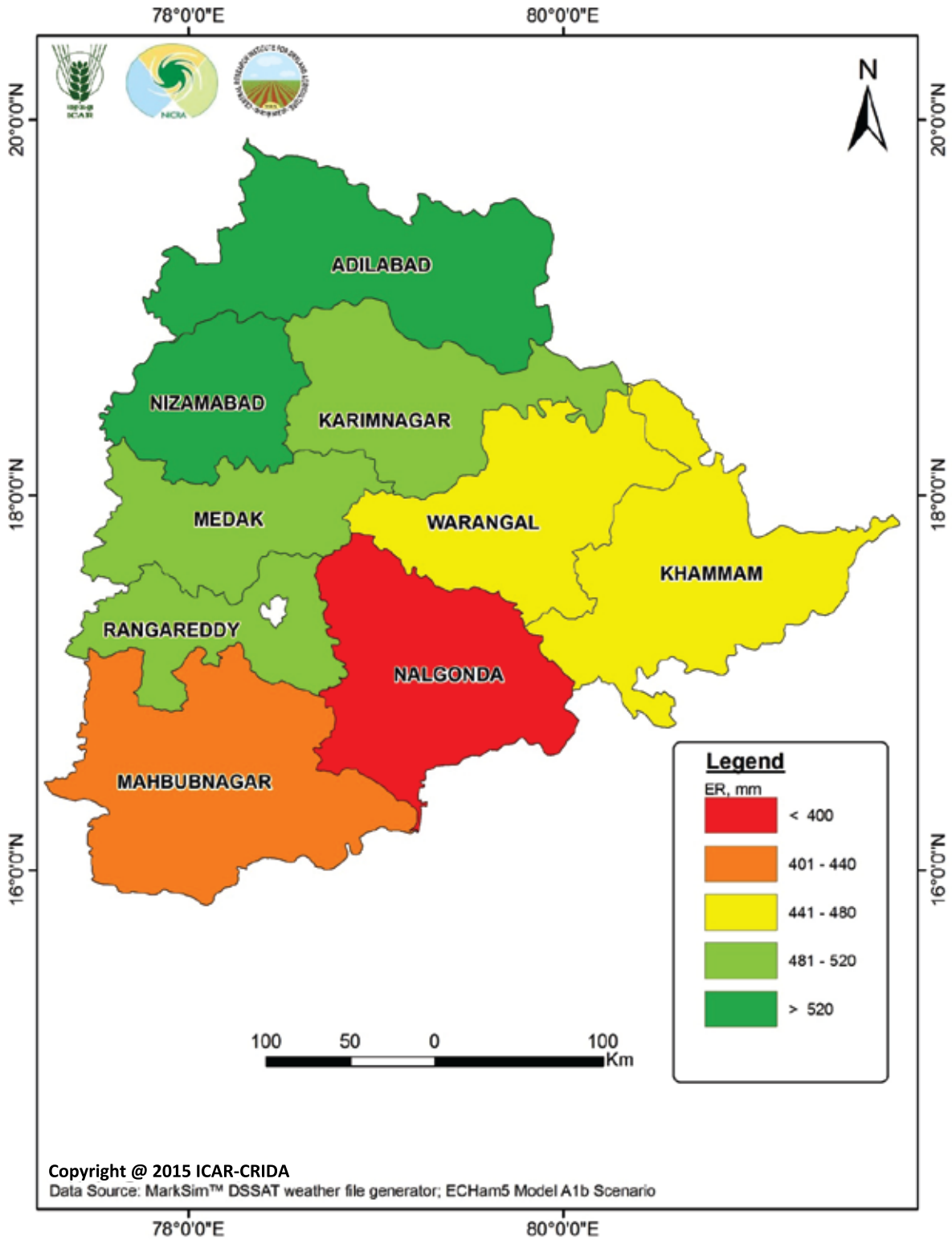

Fig.3.14 Effective rainfall (ER) during crop growth period of cotton under late sowing for the decade 2011-2020 in Telangana

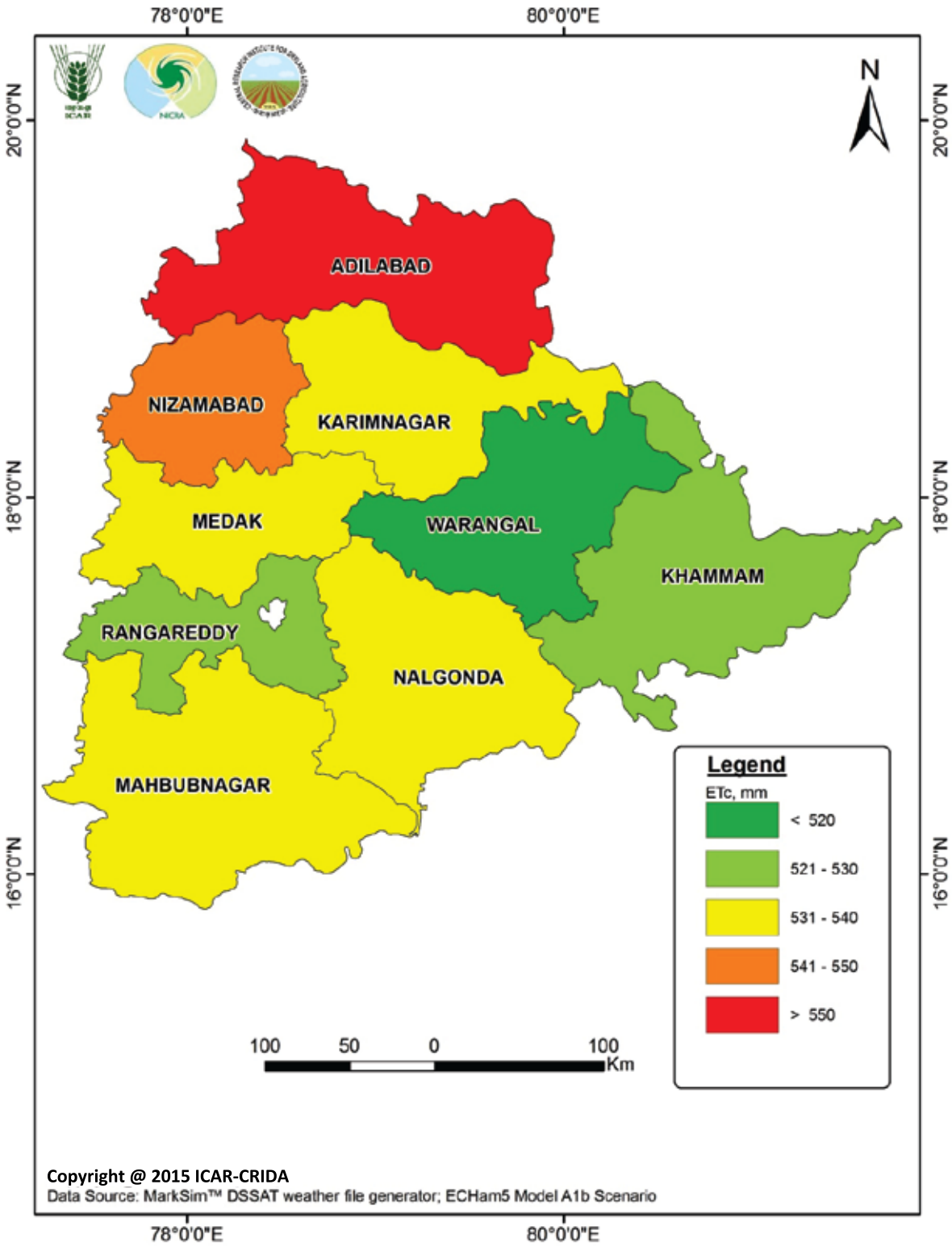

Fig.3.15 Crop evapotranspiration (ETc) during crop growth period of cotton under late sowing for the decade 2011-2020 in Telangana

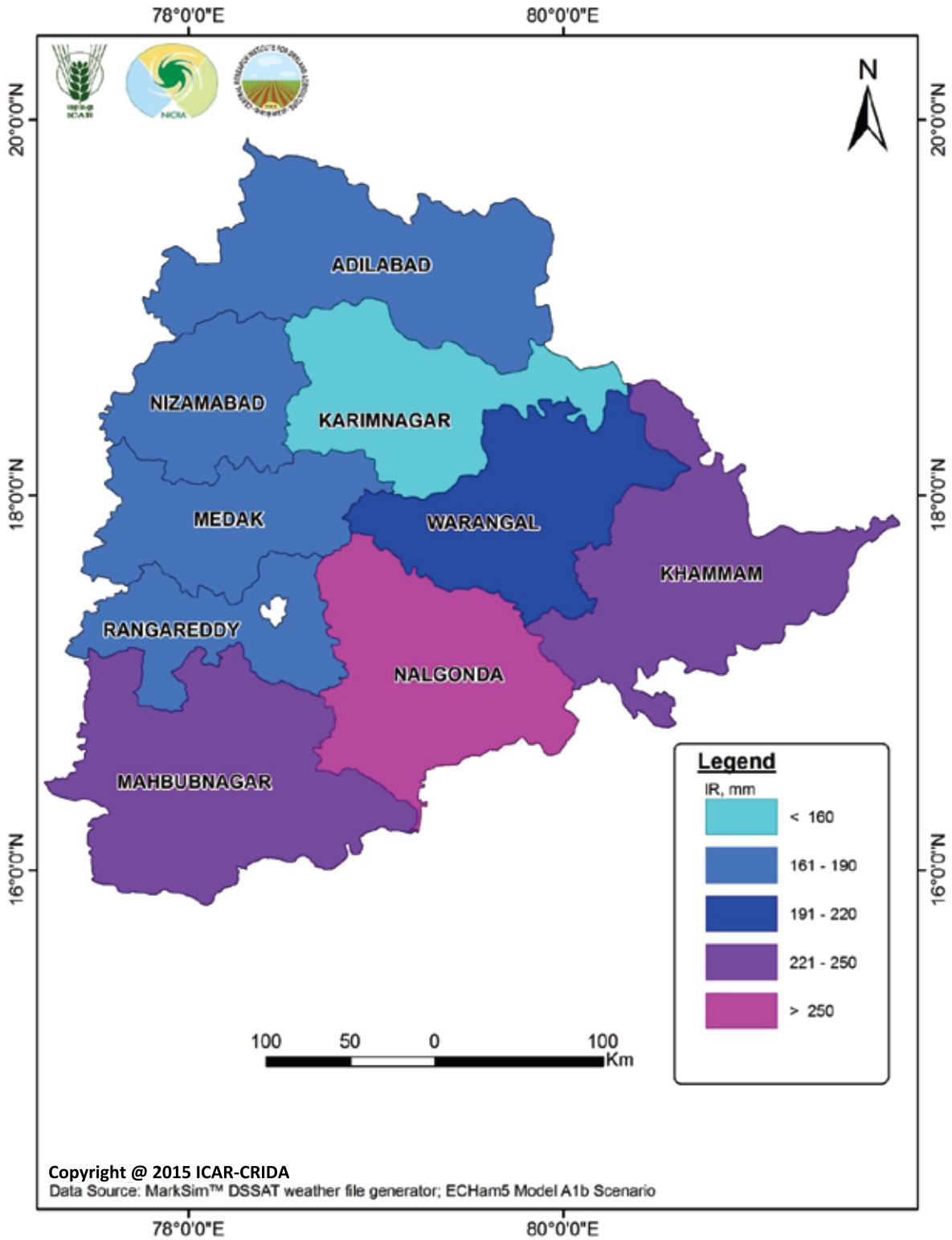

Fig.3.16 Irrigation requirement (IR) during crop growth period of cotton under late sowing for the decade 2011-2020 in Telangana

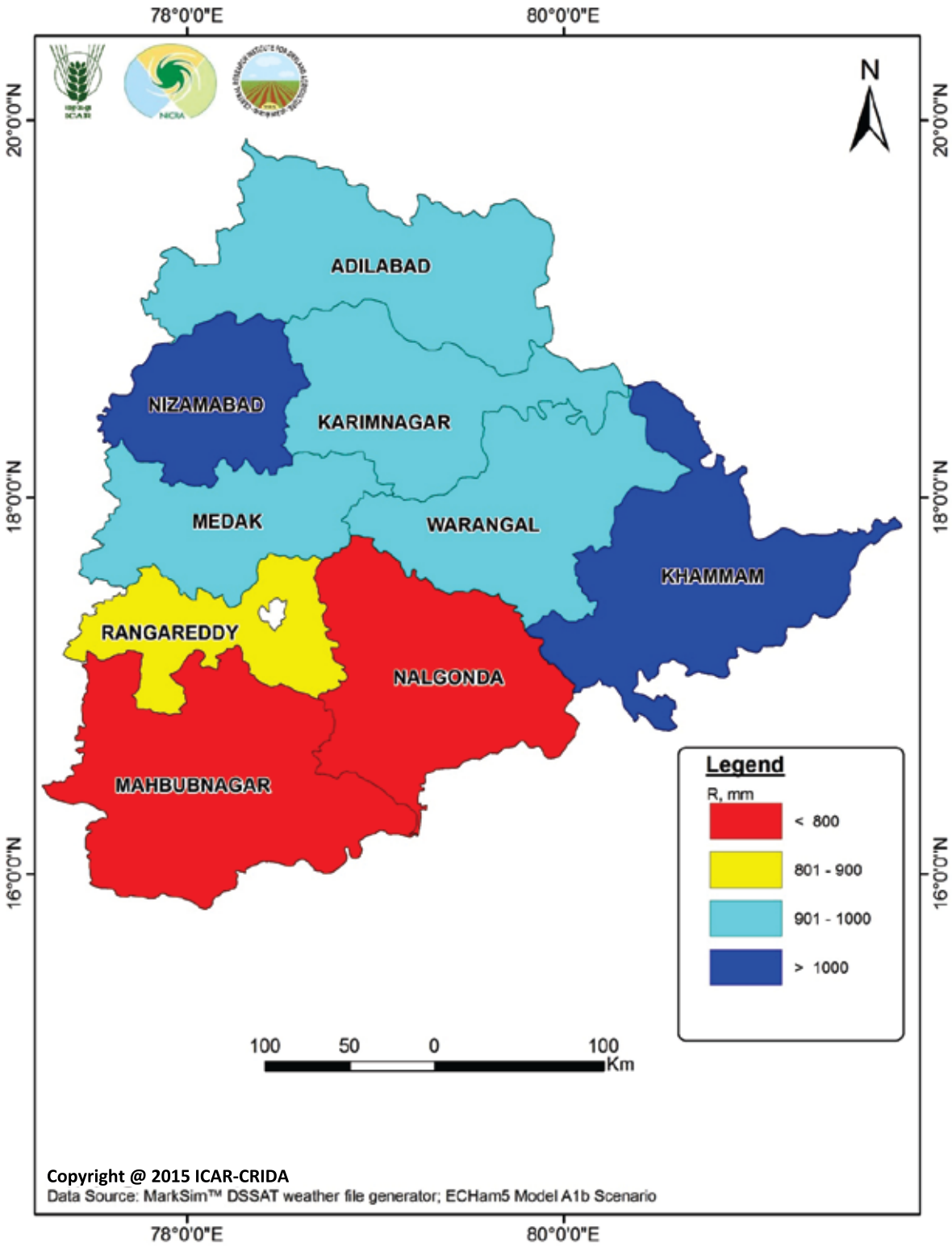

Fig.3.17 Rainfall (R) during crop growth period of cotton under normal sowing for the decade 2021-2030 in Telangana

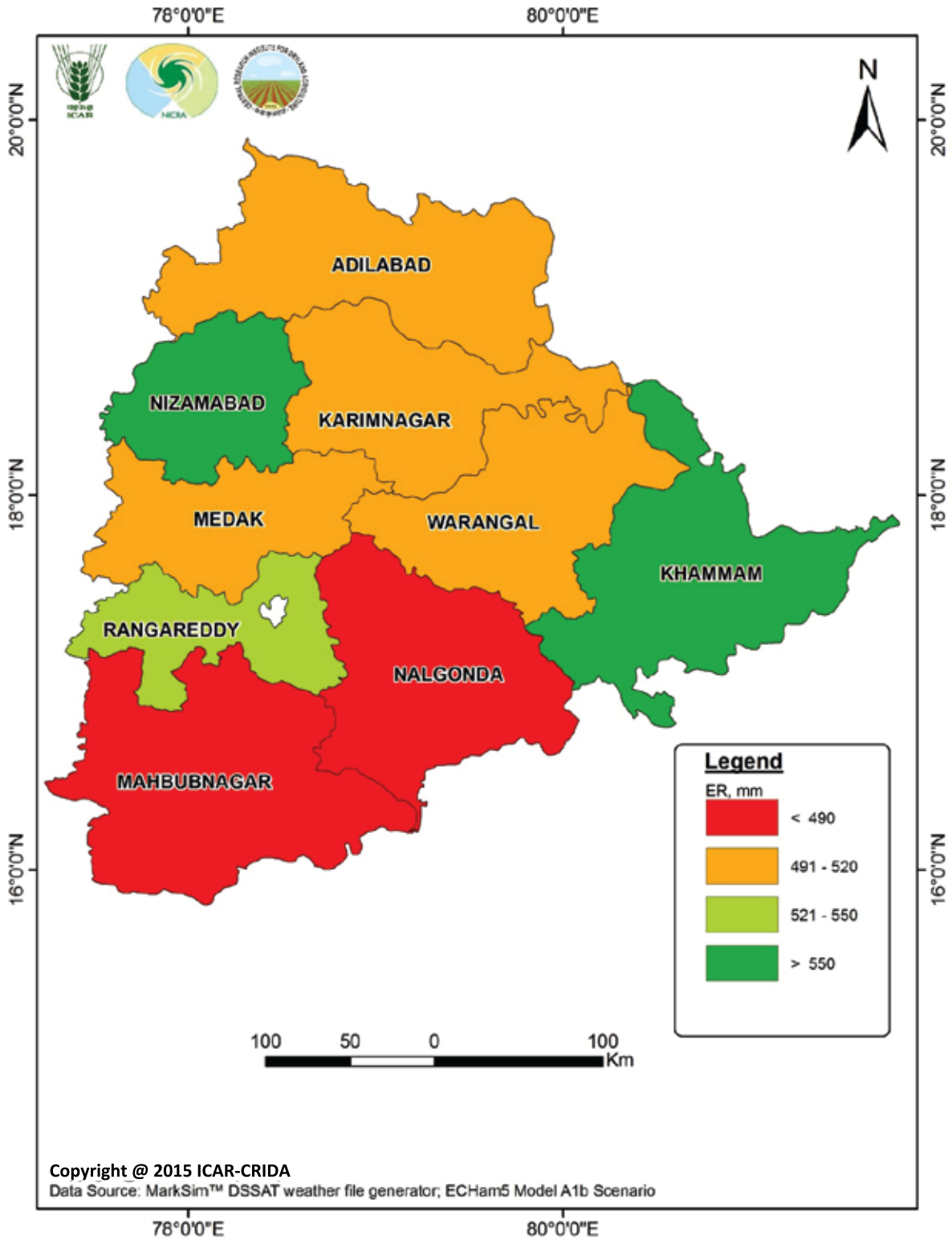

Fig.3.18 Effective rainfall (ER) during crop growth period of cotton under normal sowing for the decade 2021-2030 in Telangana

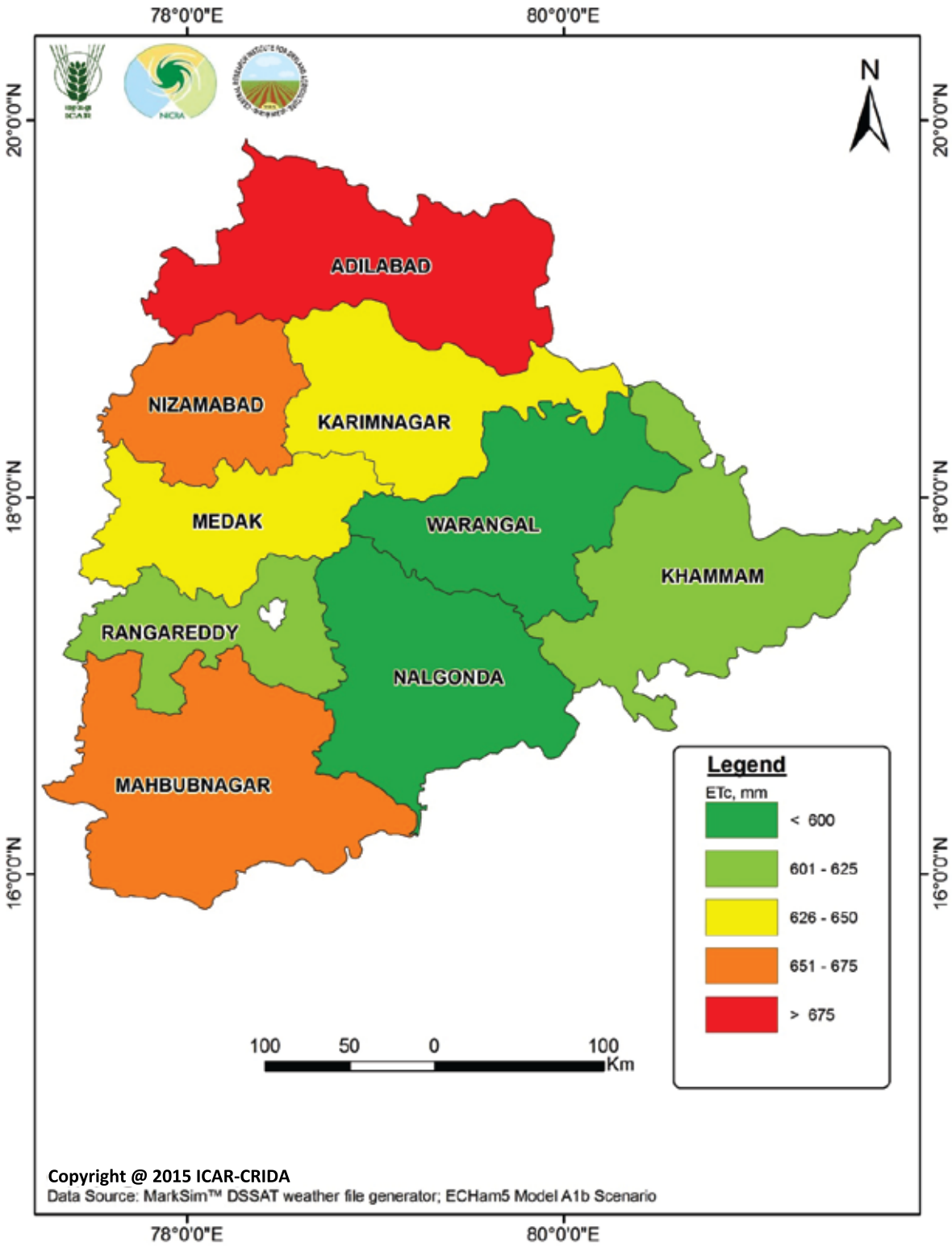

Fig.3.19 Crop evapotranspiration (ETc) during crop growth period of cotton under normal sowing for the decade 2021-2030 in Telangana

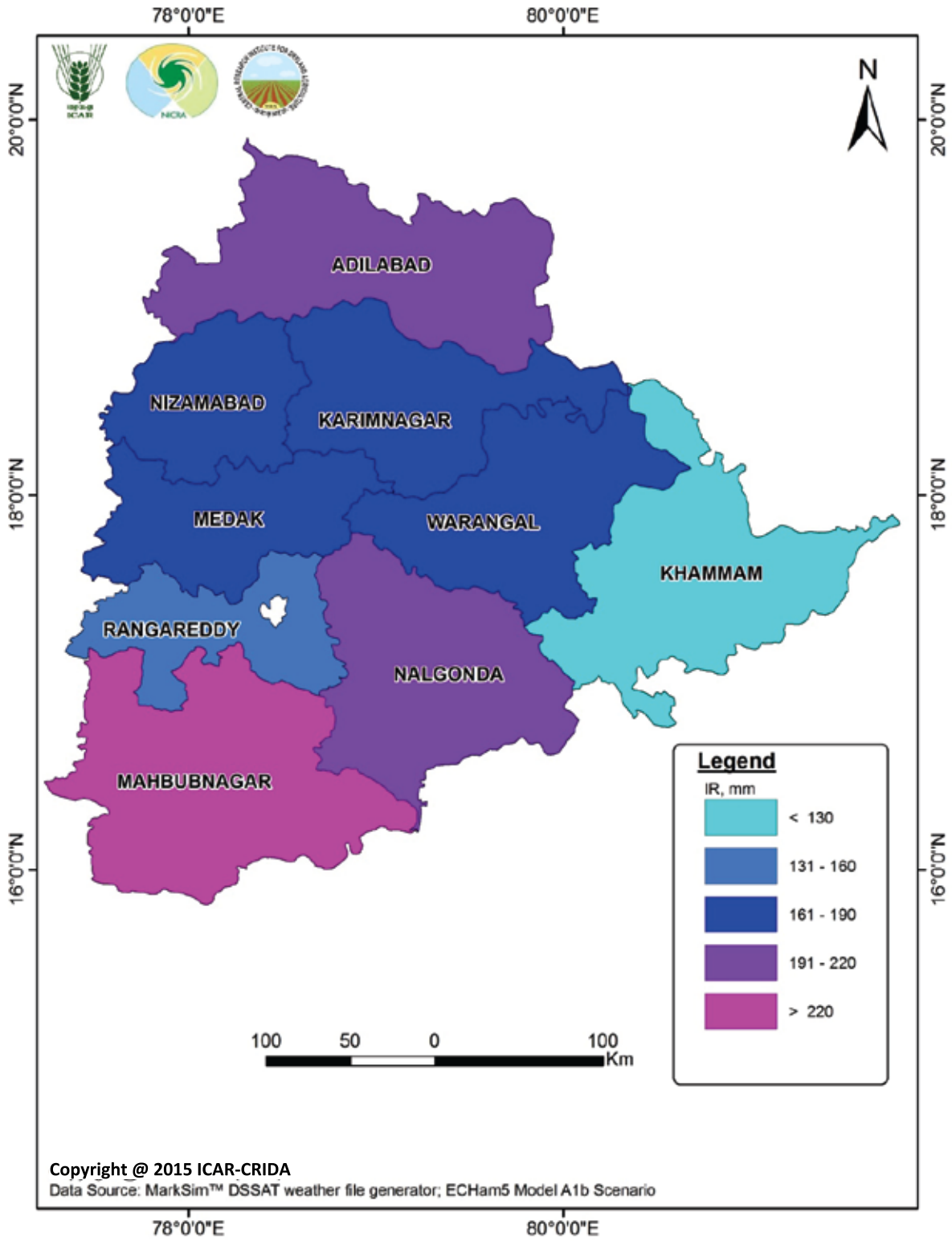

Fig.3.20 Irrigation requirement (IR) during crop growth period of cotton under normal sowing for the decade 2021-2030 in Telangana

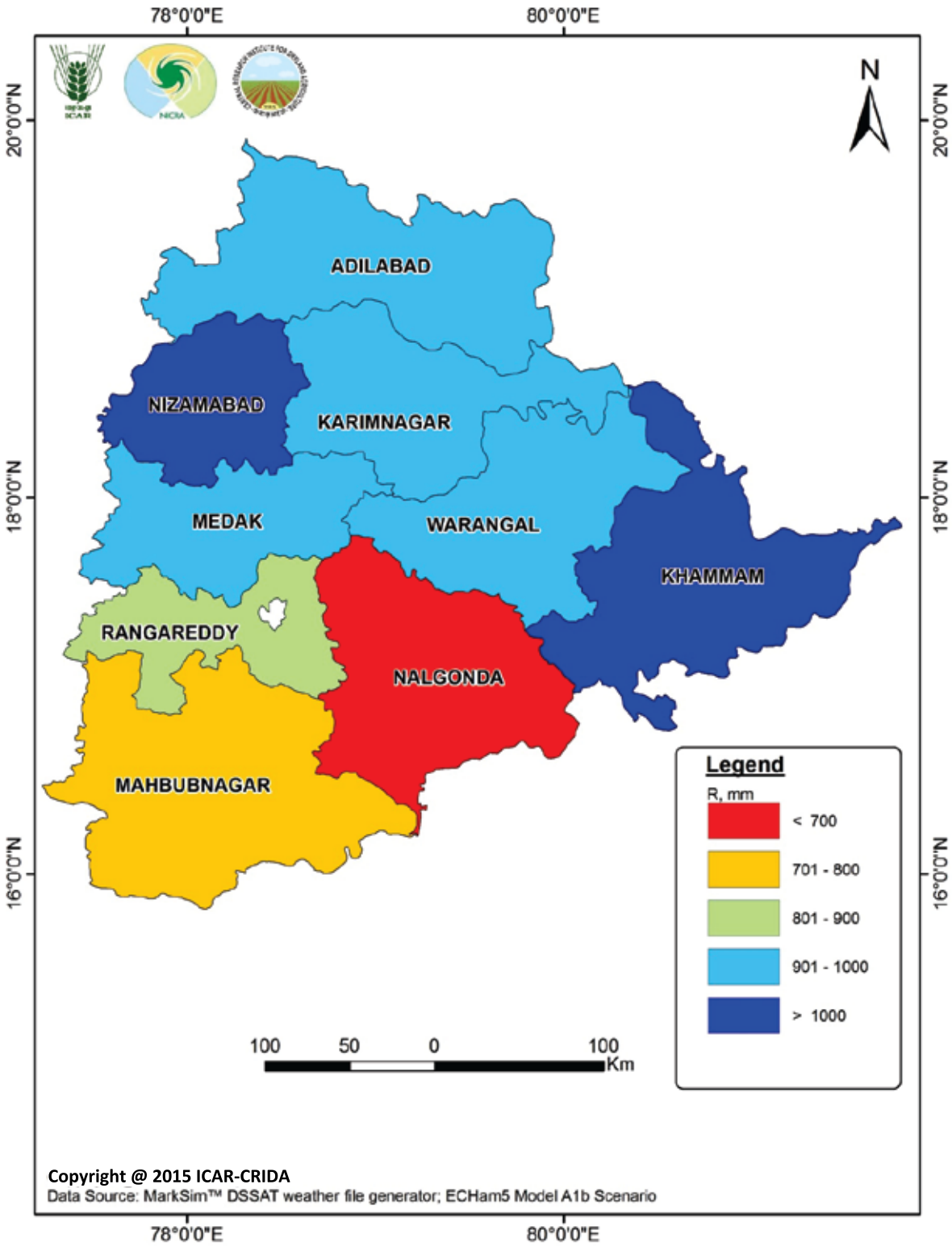

Fig.3.21 Rainfall (R) during crop growth period of cotton under late sowing for the decade 2021-2030 in Telangana

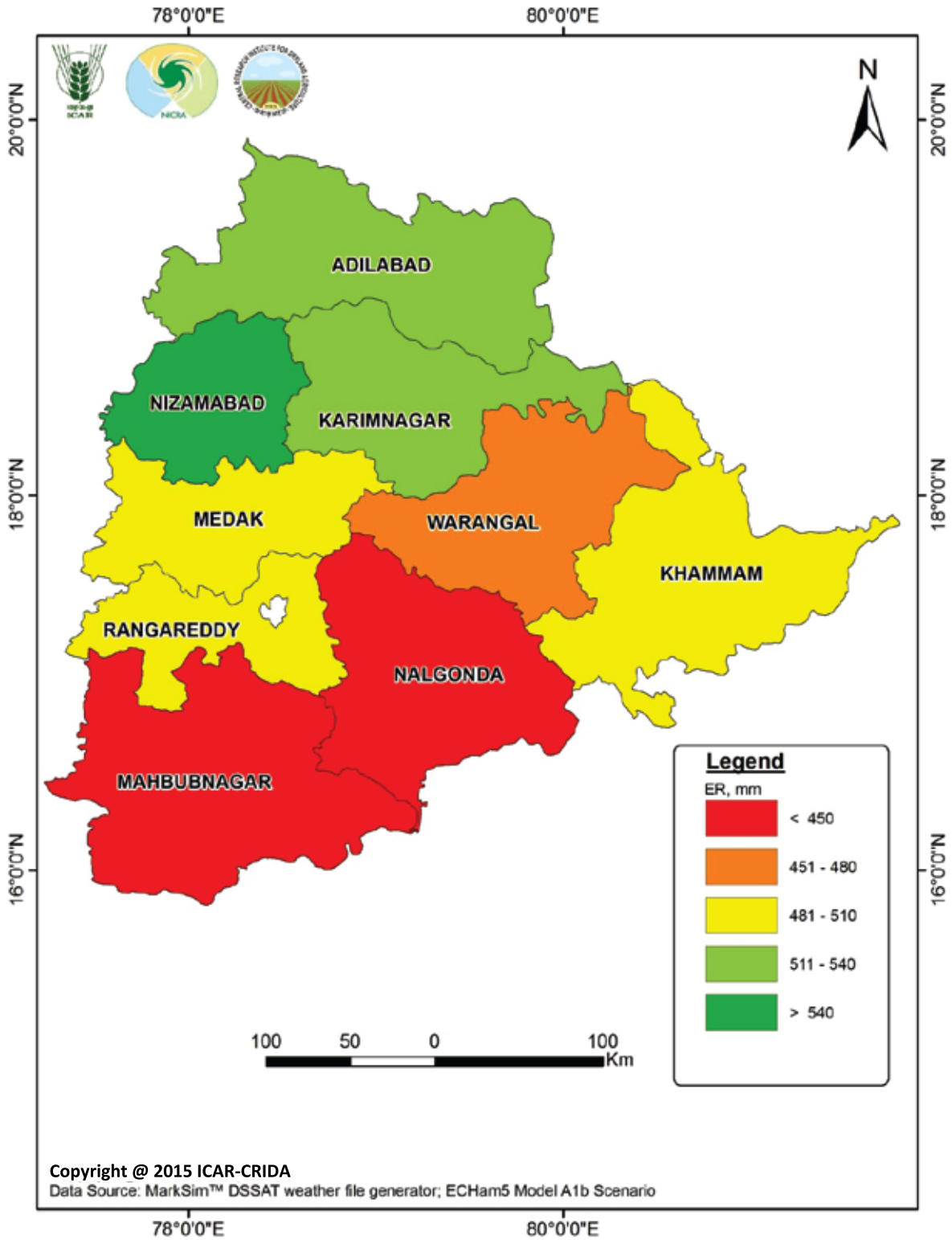

Fig.3.22 Effective rainfall (ER) during crop growth period of cotton under late sowing for the decade 2021-2030 in Telangana

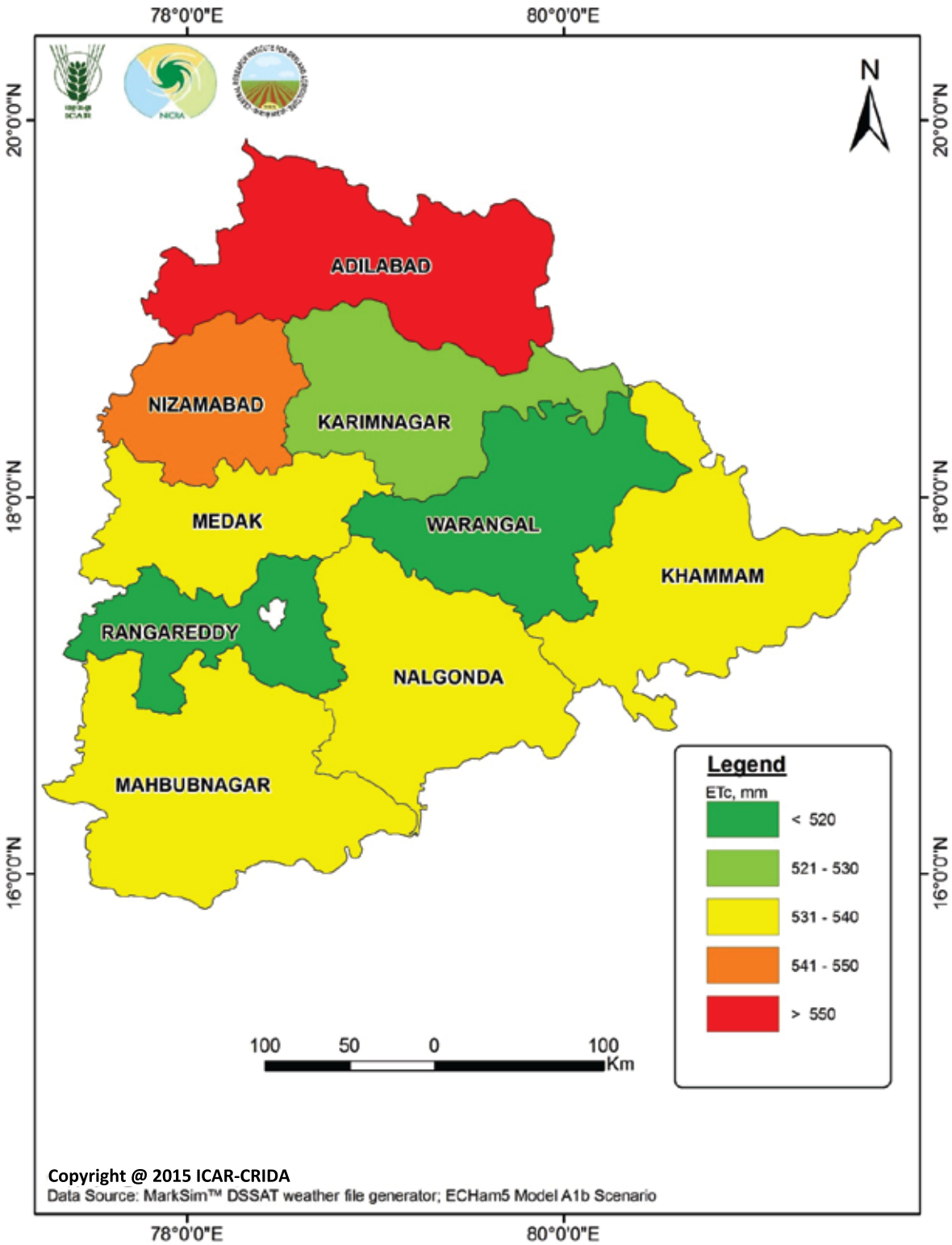

Fig.3.23 Crop evapotranspiration (ETc) during crop growth period of cotton under late sowing for the decade 2021-2030 in Telangana

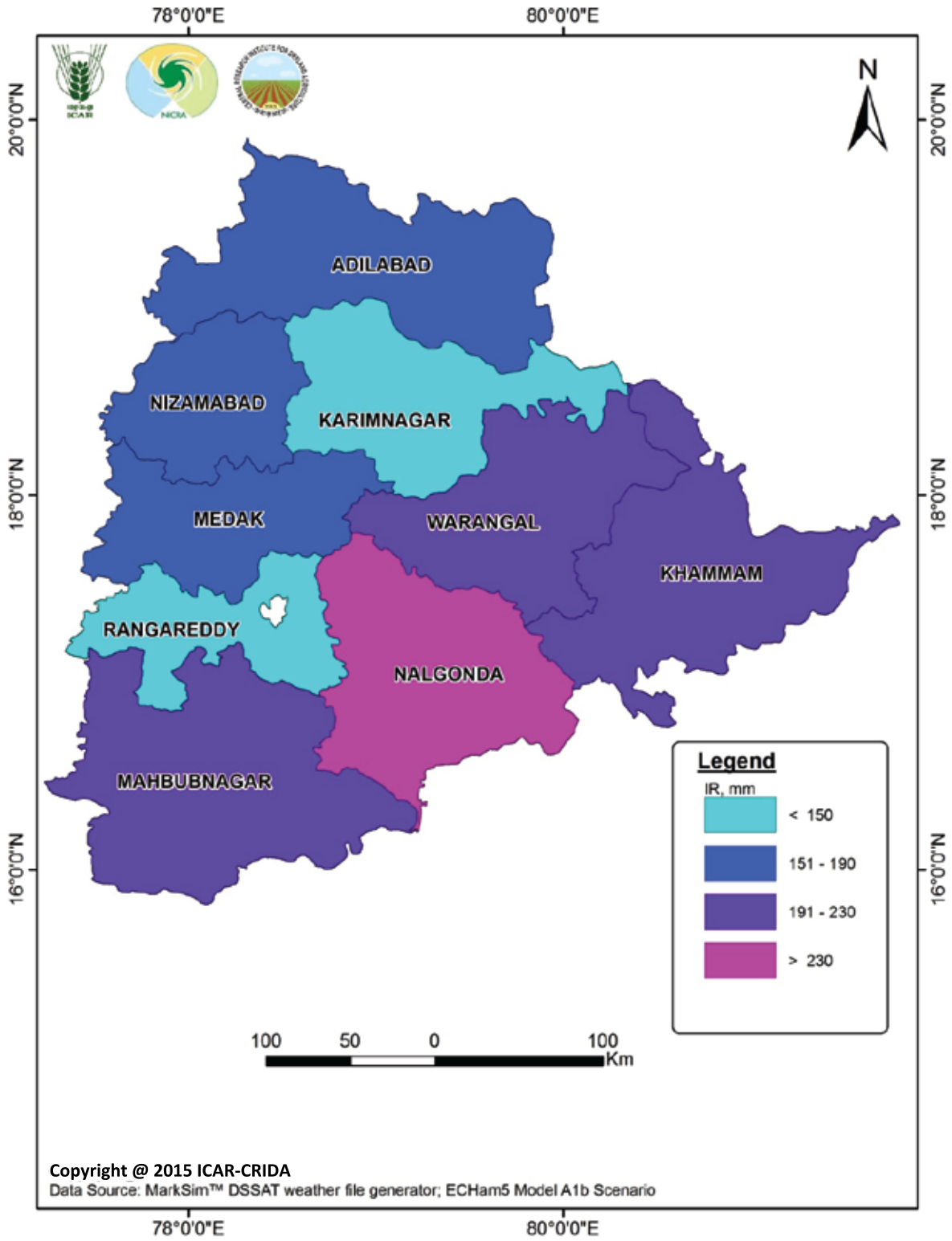

Fig.3.24 Irrigation requirement (IR) during crop growth period of cotton under late sowing for the decade 2021-2030 in Telangana

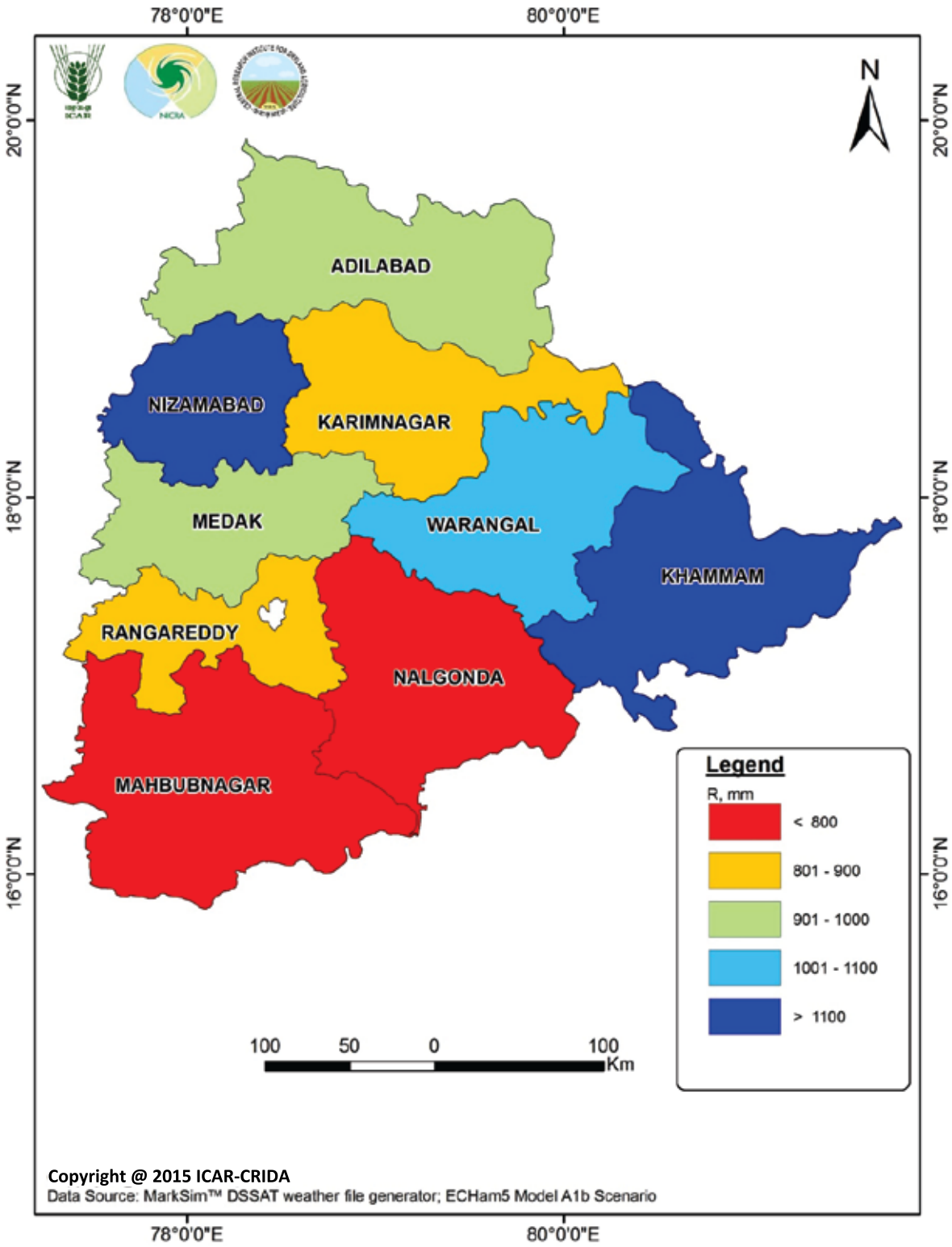

Fig.3.25 Rainfall (R) during crop growth period of cotton under normal sowing for the decade 2031-2040 in Telangana

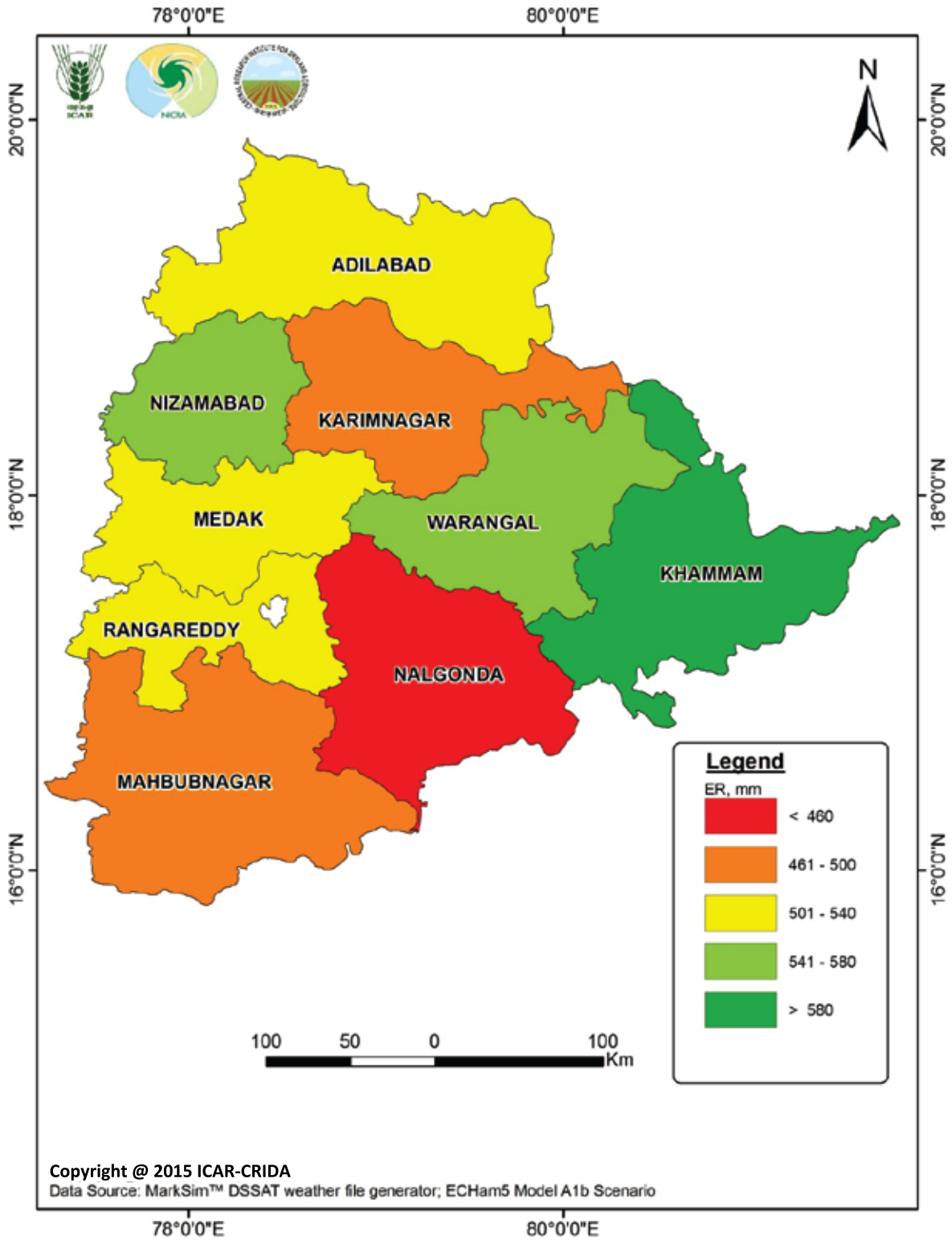

Fig.3.26 Effective rainfall (ER) during crop growth period of cotton under normal sowing for the decade 2031-2040 in Telangana

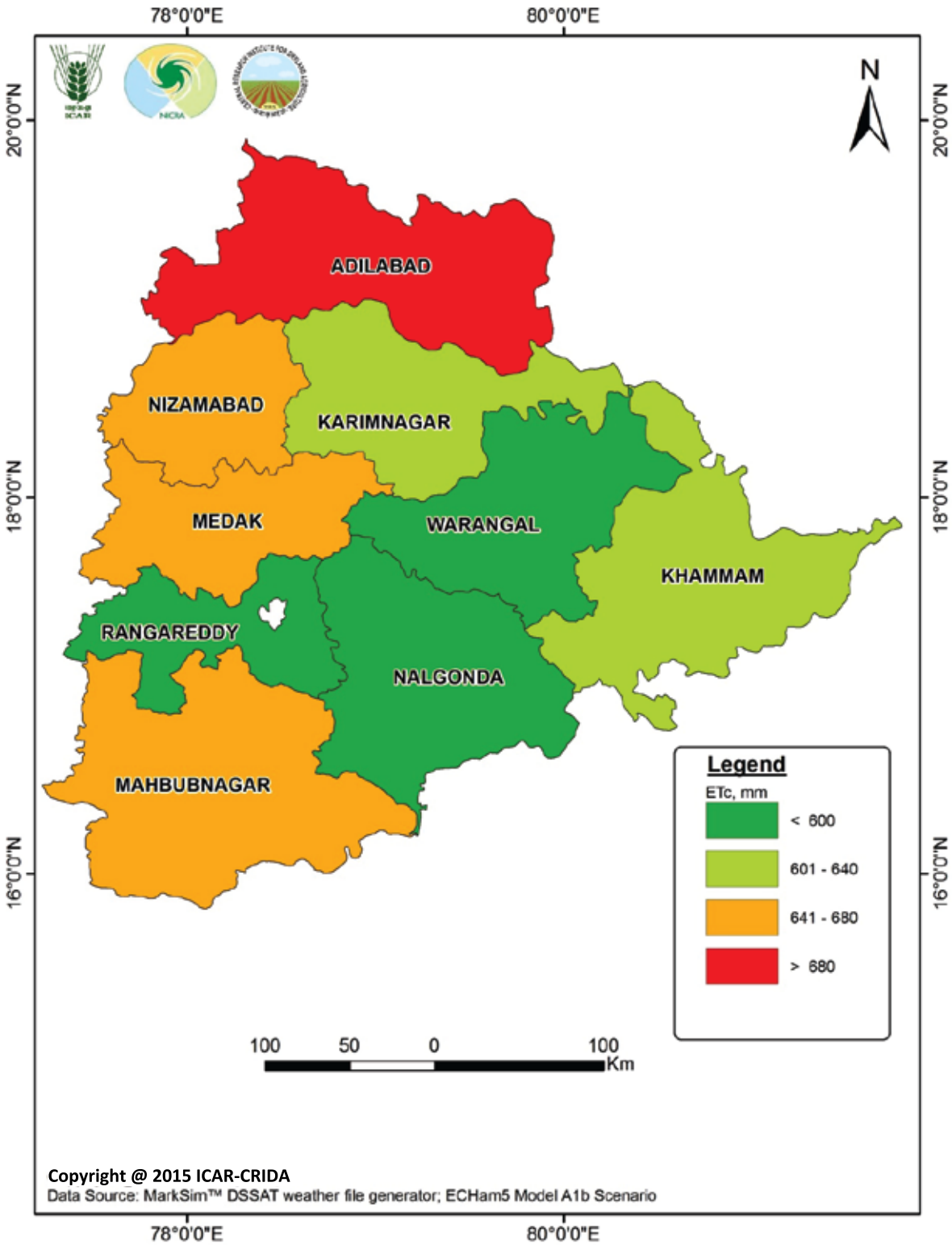

Fig.3.27 Crop evapotranspiration (ETc) during crop growth period of cotton under normal sowing for the decade 2031-2040 in Telangana

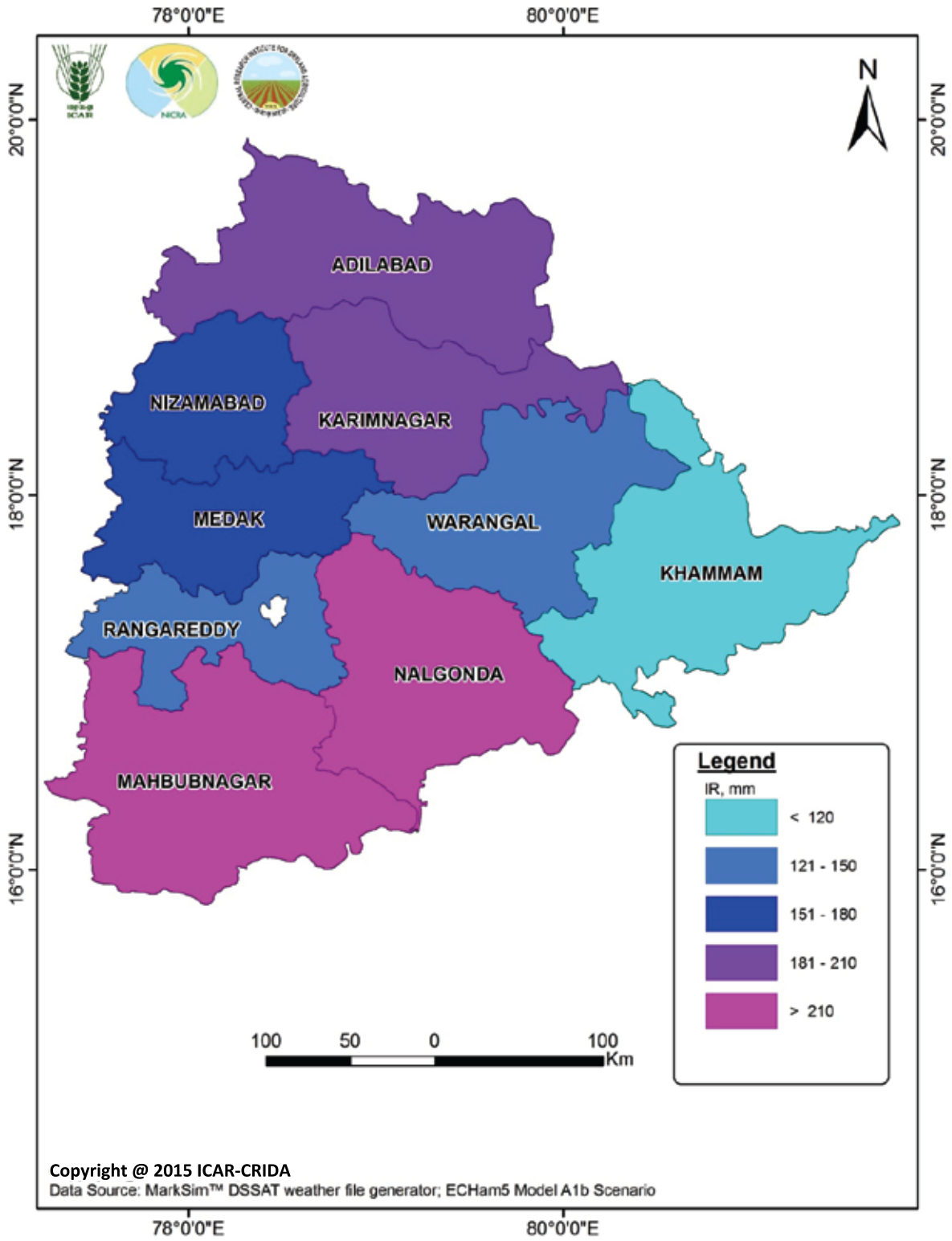

Fig.3.28 Irrigation requirement (IR) during crop growth period of cotton under normal sowing for the decade 2031-2040 in Telangana

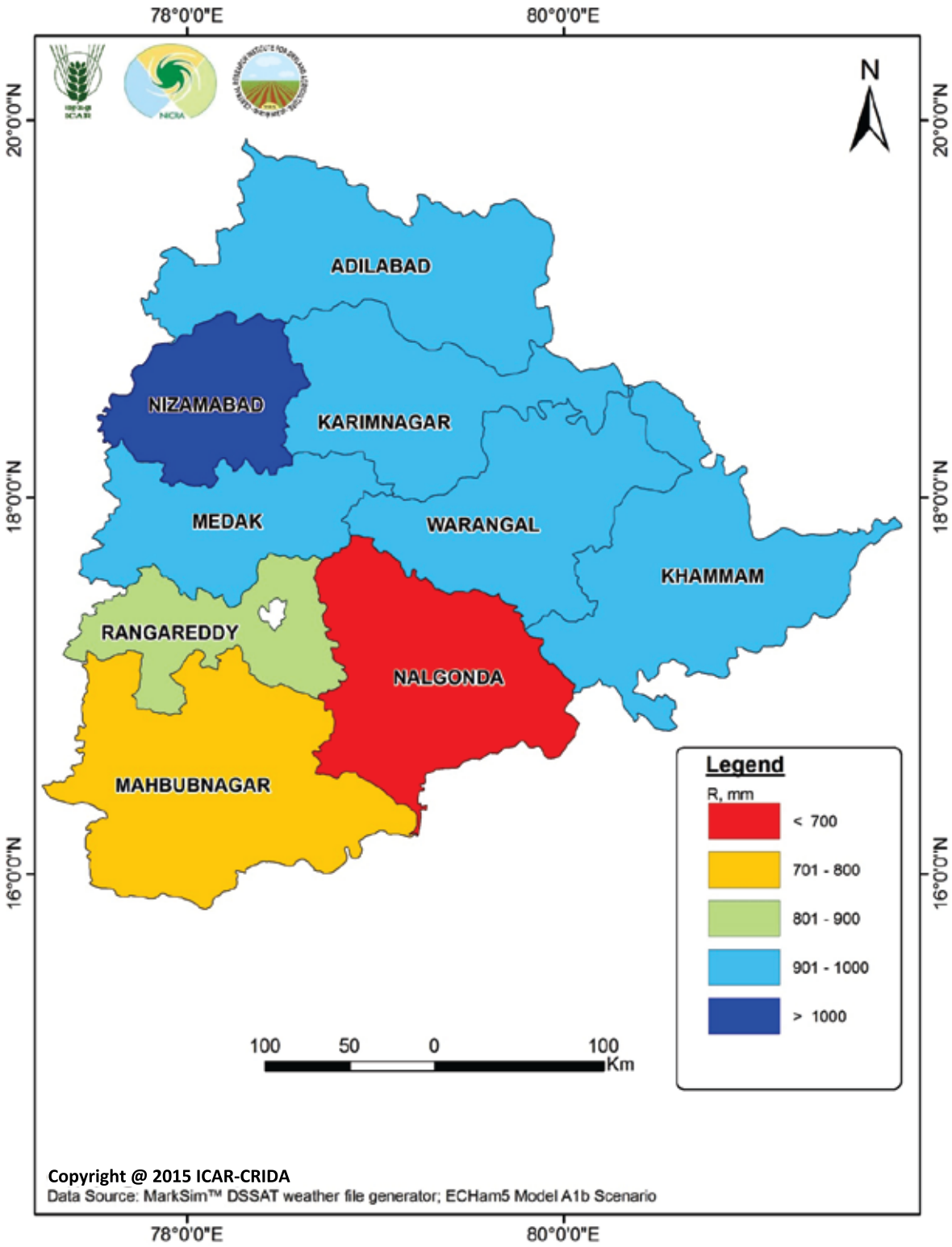

Fig.3.29 Rainfall (R) during crop growth period of cotton under late sowing for the decade 2031-2040 in Telangana

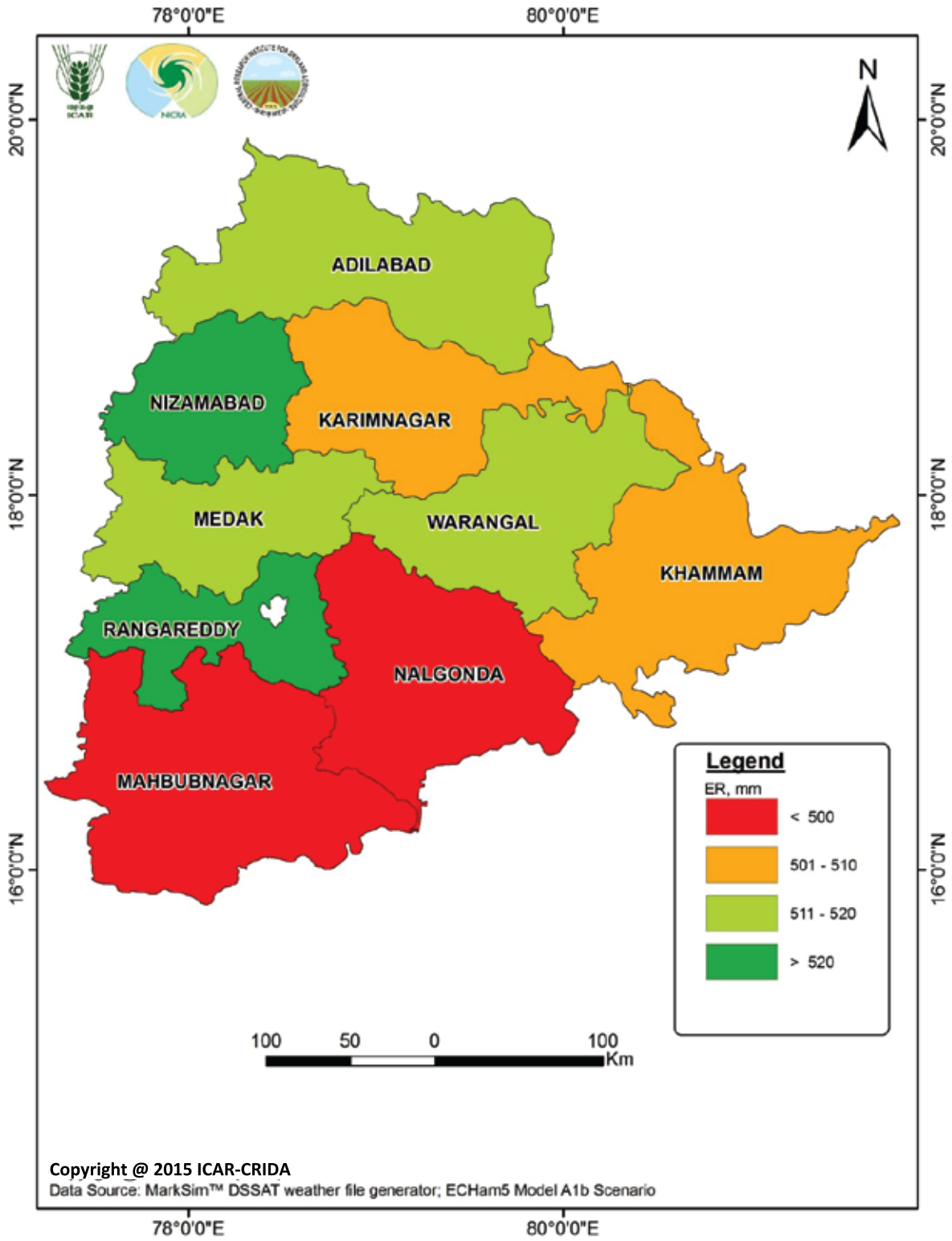

Fig.3.30 Effective rainfall (ER) during crop growth period of cotton under late sowing for the decade 2031-2040 in Telangana

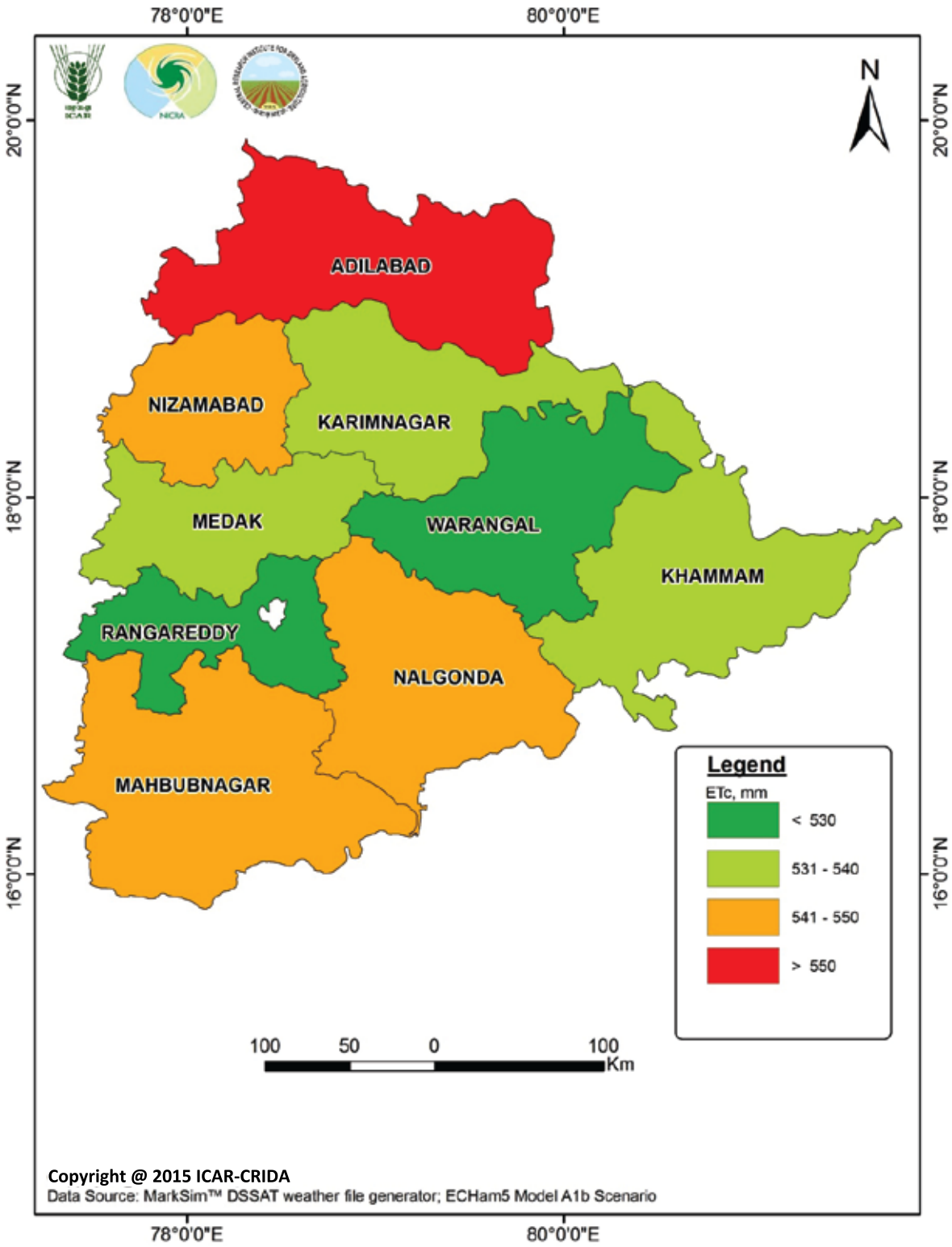

Fig.3.31 Crop evapotranspiration (ETc) during crop growth period of cotton under late sowing for the decade 2031-2040 in Telangana

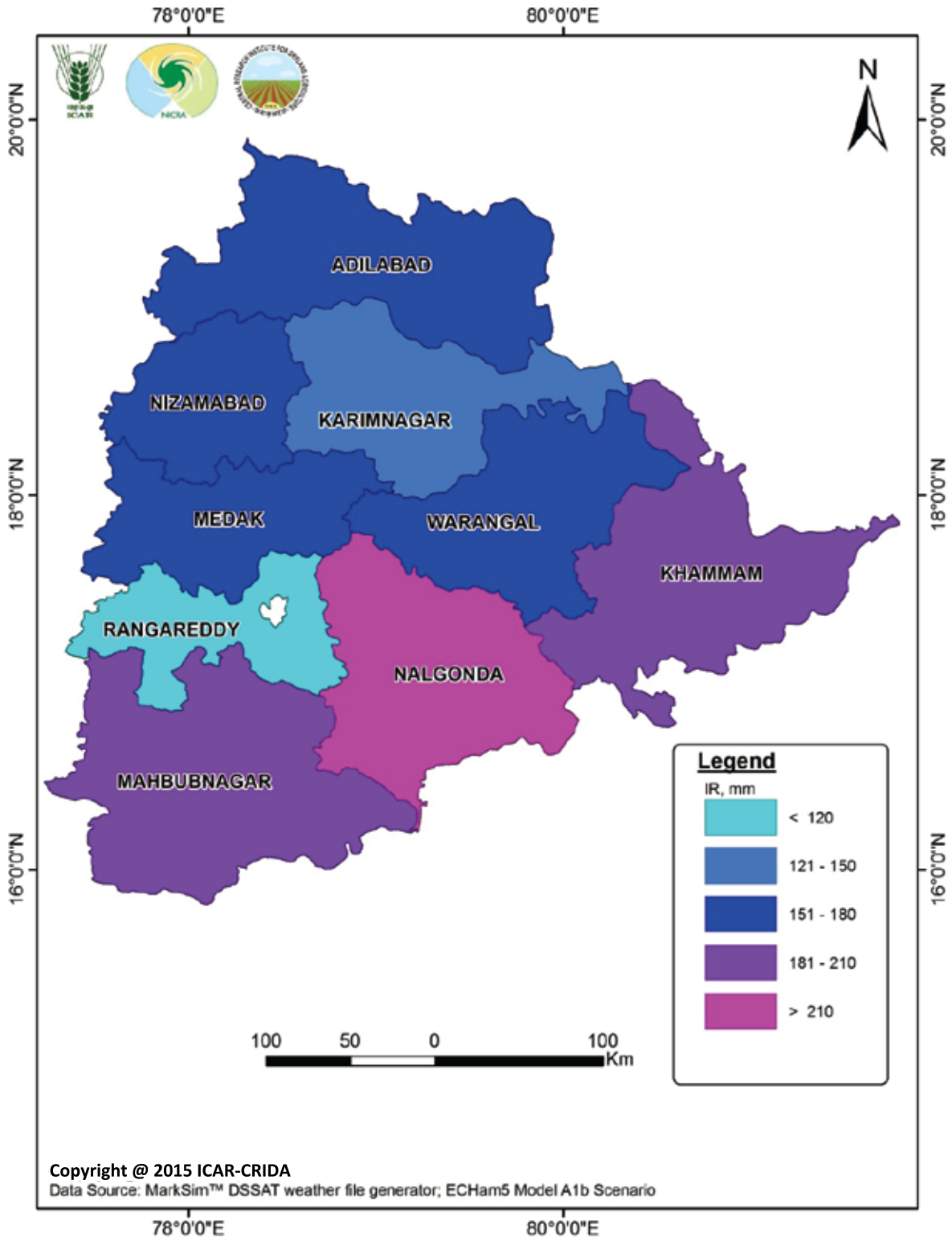

Fig.3.32 Irrigation requirement (IR) during crop growth period of cotton under late sowing for the decade 2031-2040 in Telangana

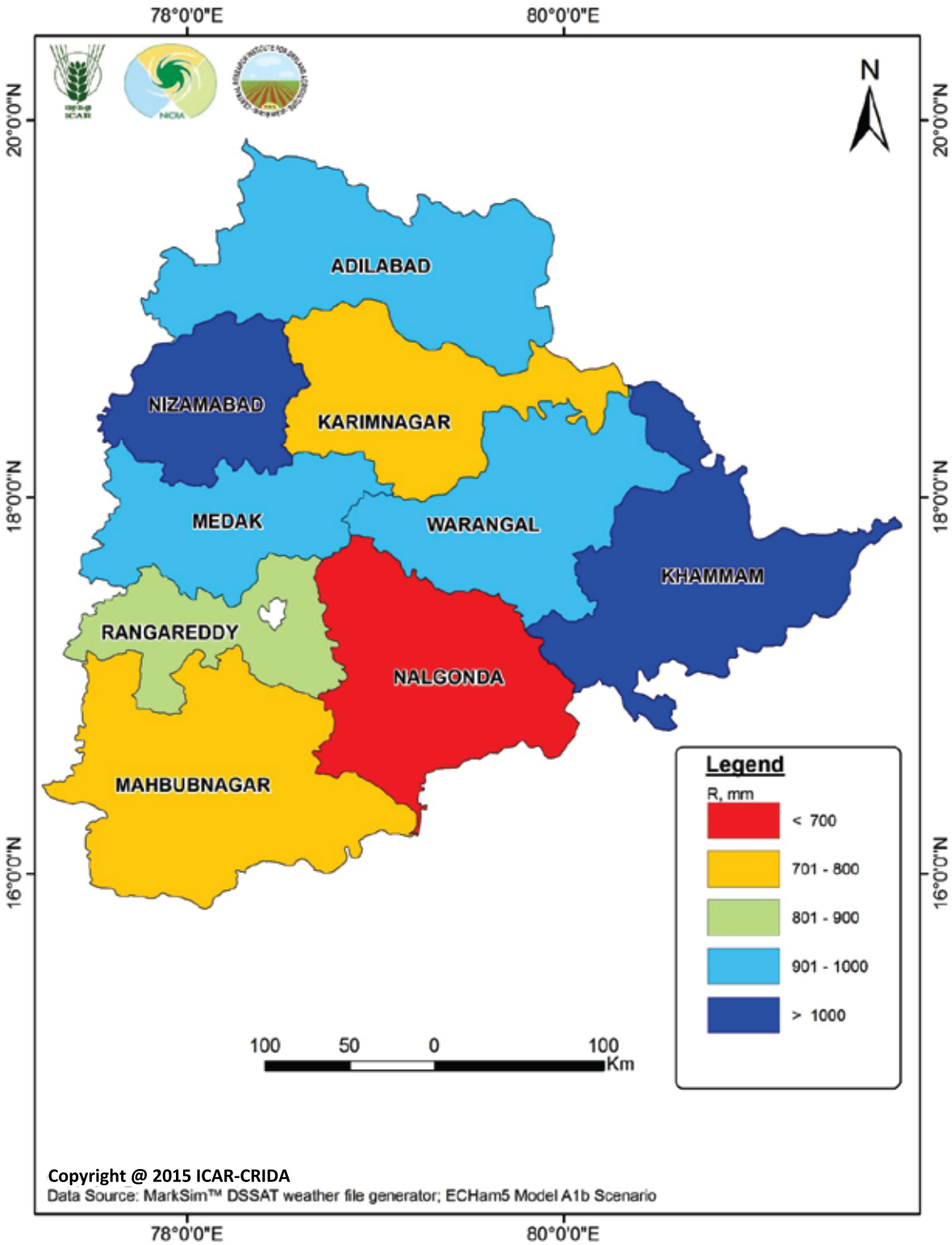

Fig.3.33 Rainfall (R) during crop growth period of cotton under normal sowing for the decade 2041-2050 in Telangana

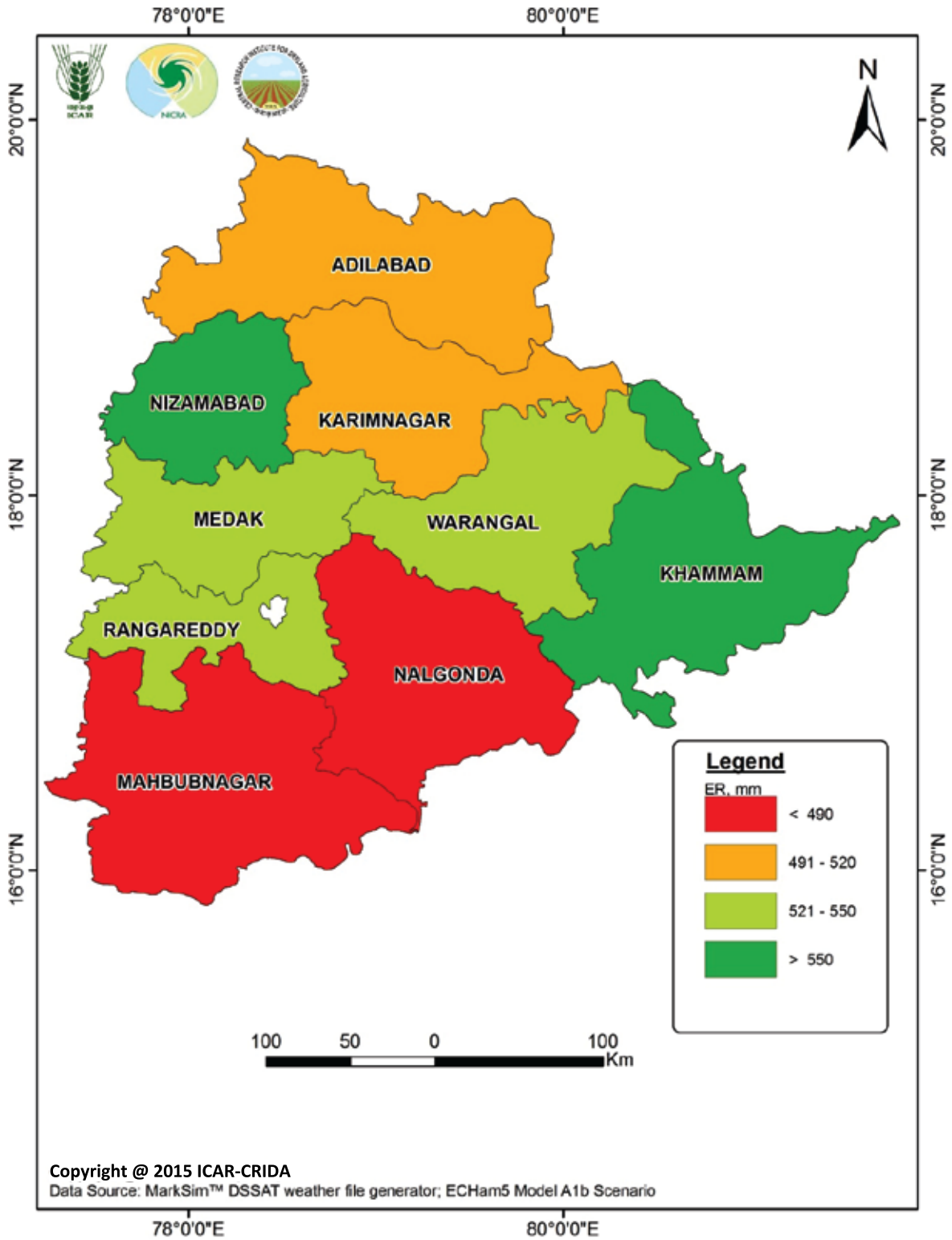

Fig.3.34 Effective rainfall (ER) during crop growth period of cotton under normal sowing for the decade 2041-2050 in Telangana

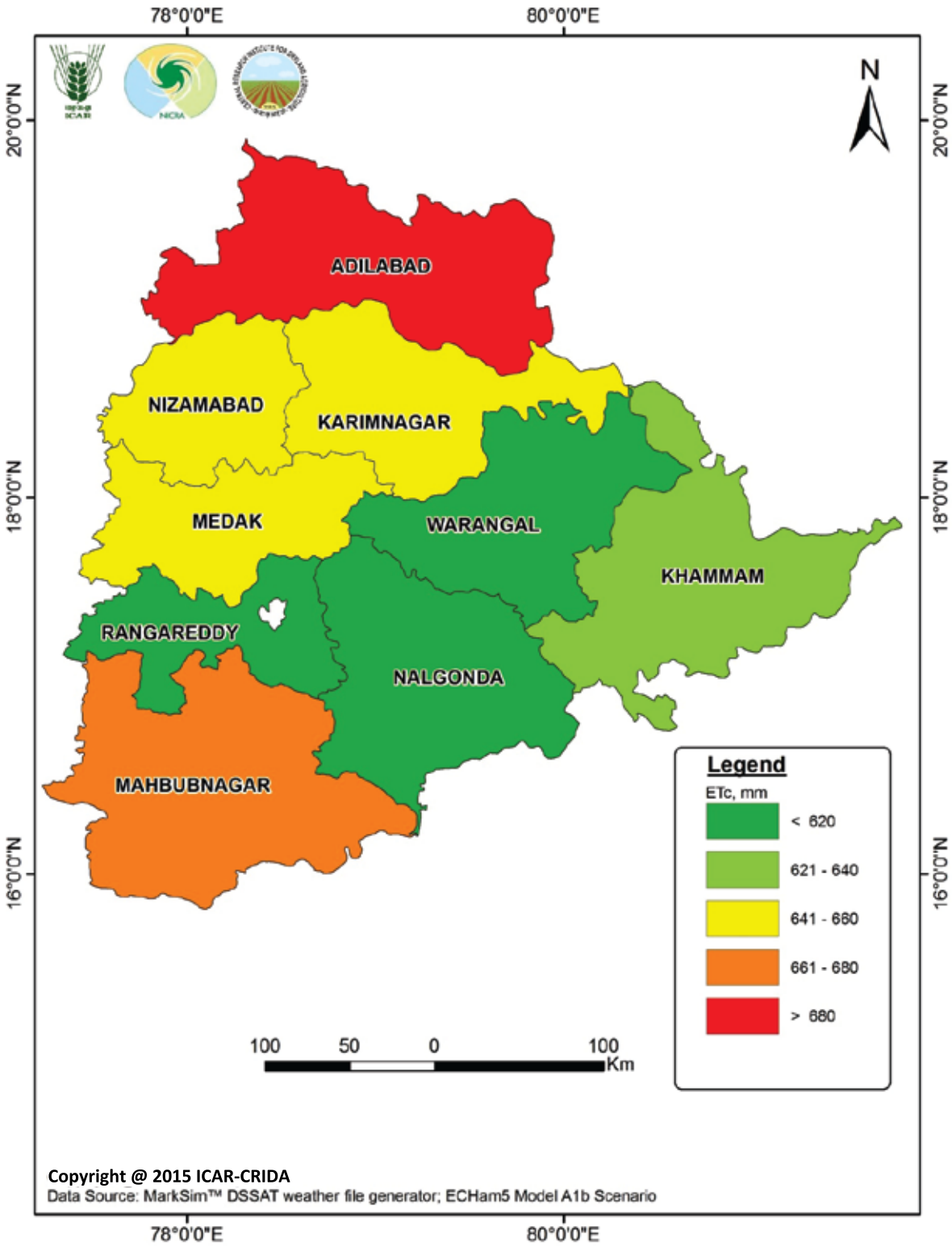

Fig.3.35 Crop evapotranspiration (ETc) during crop growth period of cotton under normal sowing for the decade 2041-2050 in Telangana

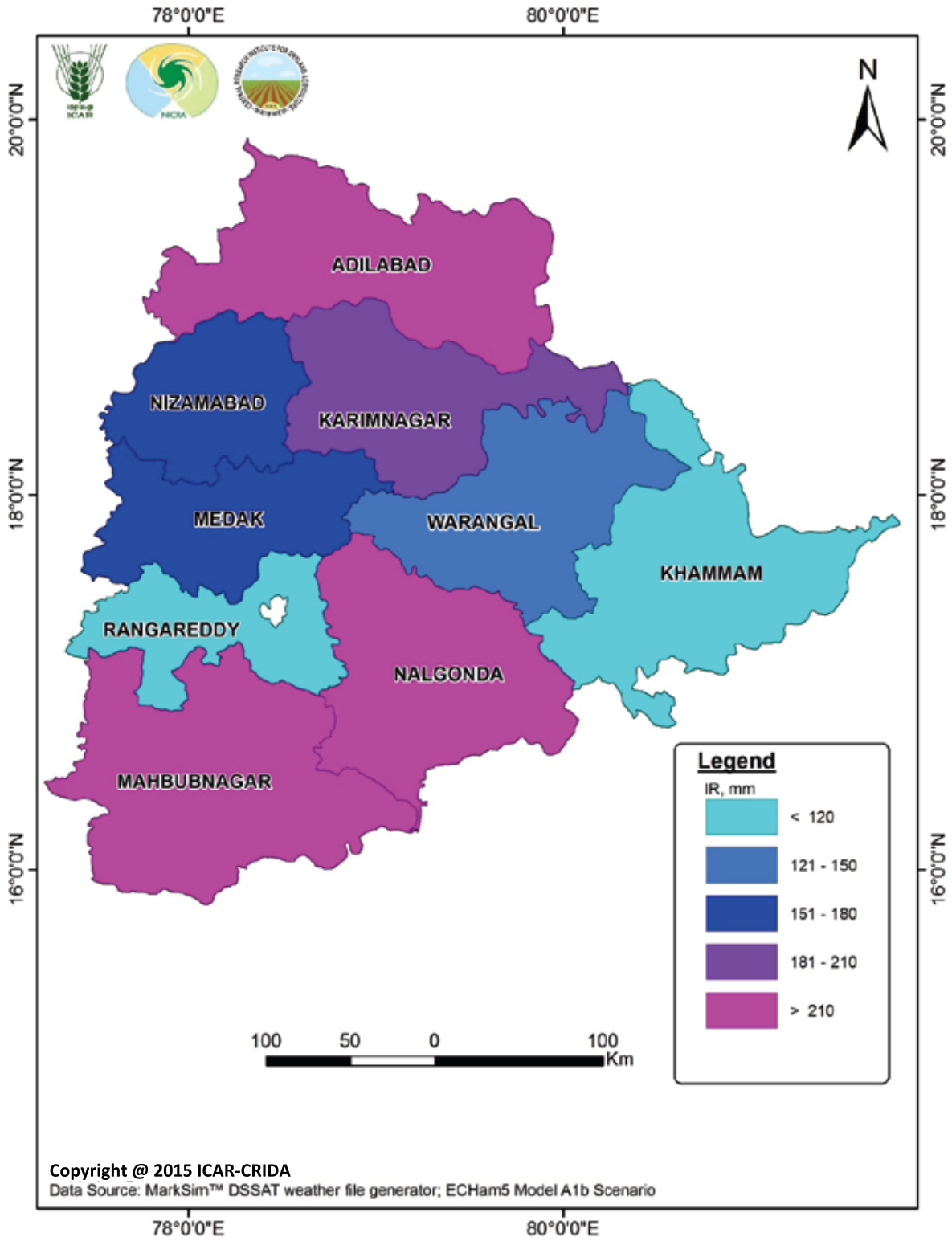

Fig.3.36 Irrigation requirement (IR) during crop growth period of cotton under normal sowing for the decade 2041-2050 in Telangana

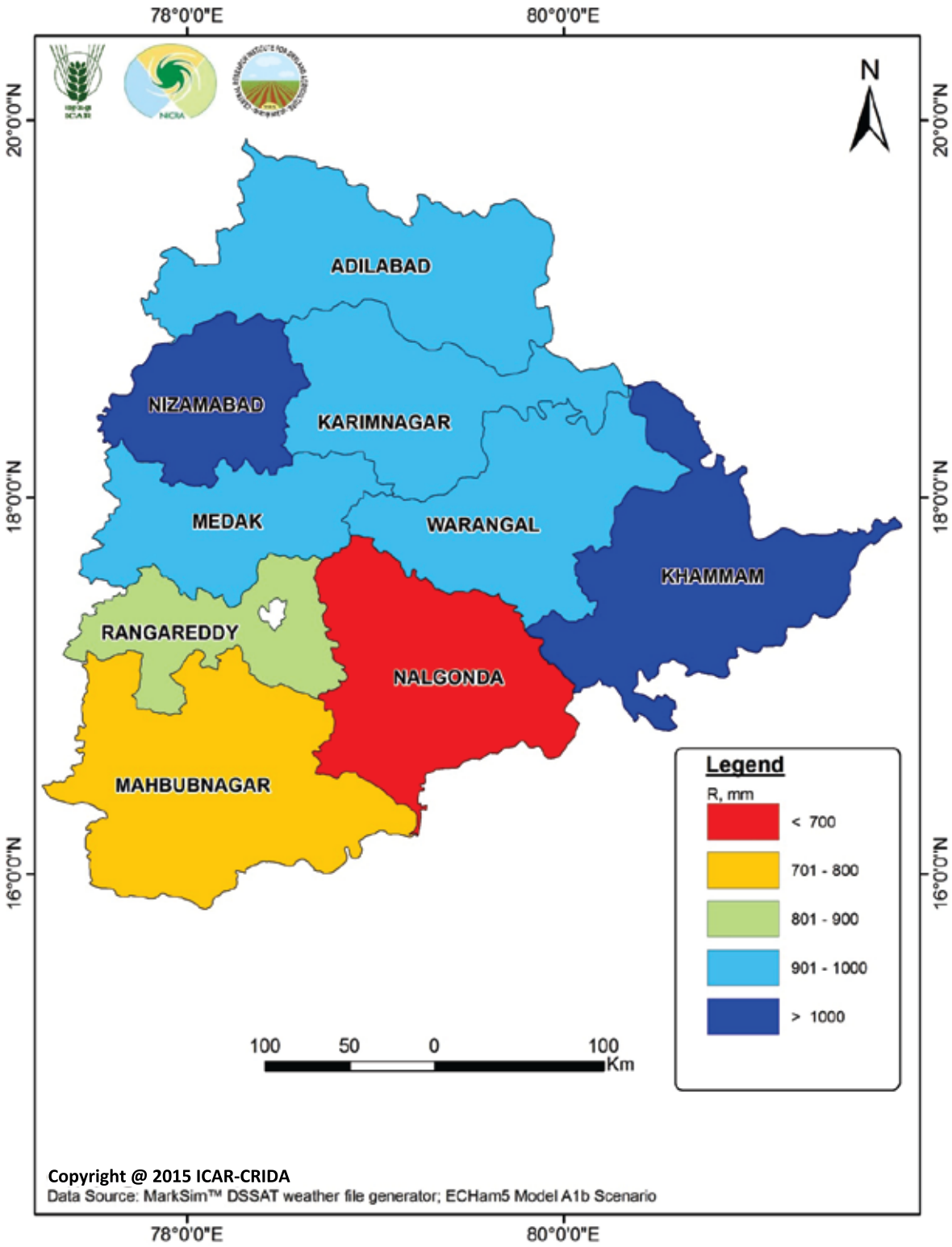

Fig.3.37 Rainfall (R) during crop growth period of cotton under late sowing for the decade 2041-2050 in Telangana

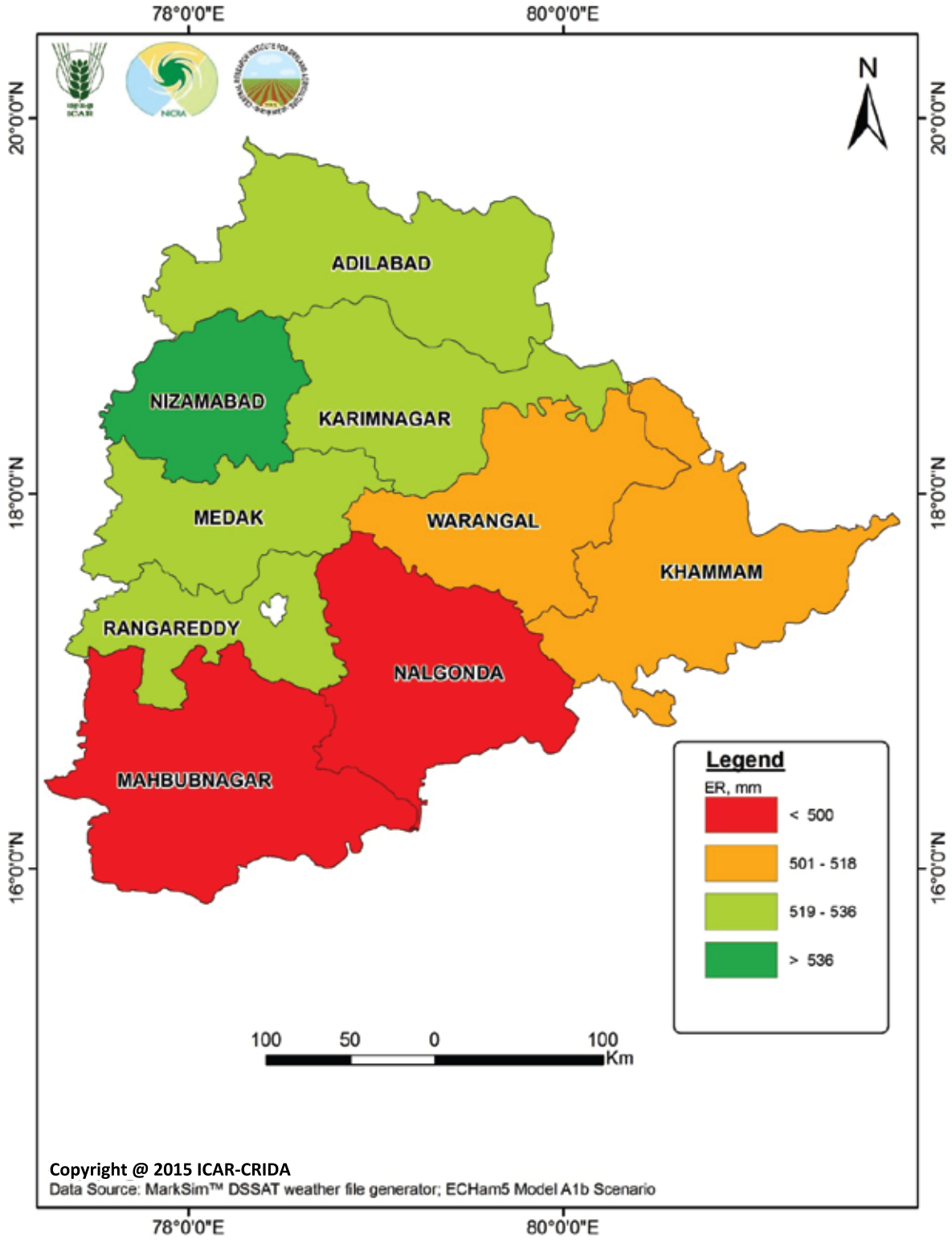

Fig.3.38 Effective rainfall (ER) during crop growth period of cotton under late sowing for the decade 2041-2050 in Telangana

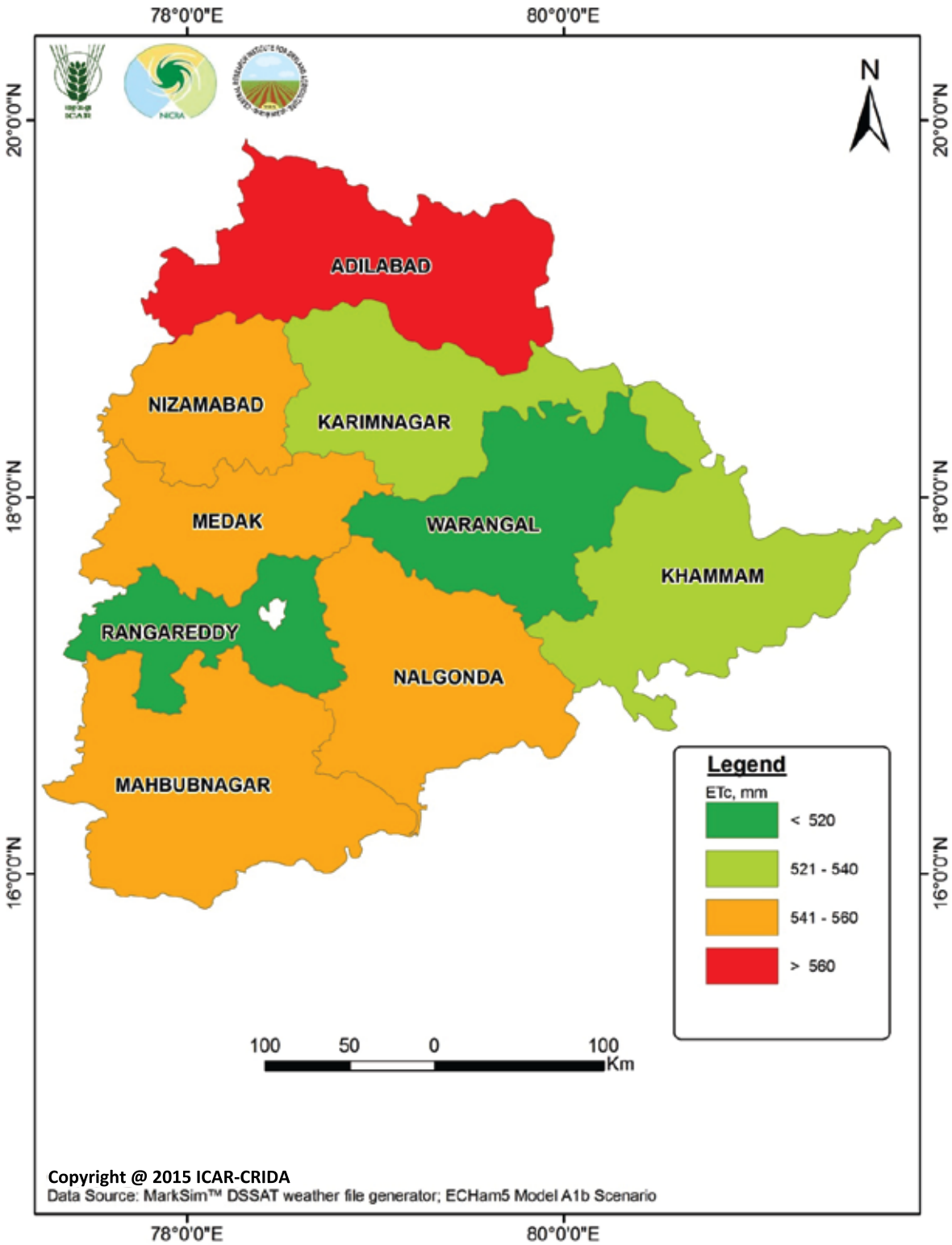

Fig.3.39 Crop evapotranspiration (ETc) during crop growth period of cotton under late sowing for the decade 2041-2050 in Telangana

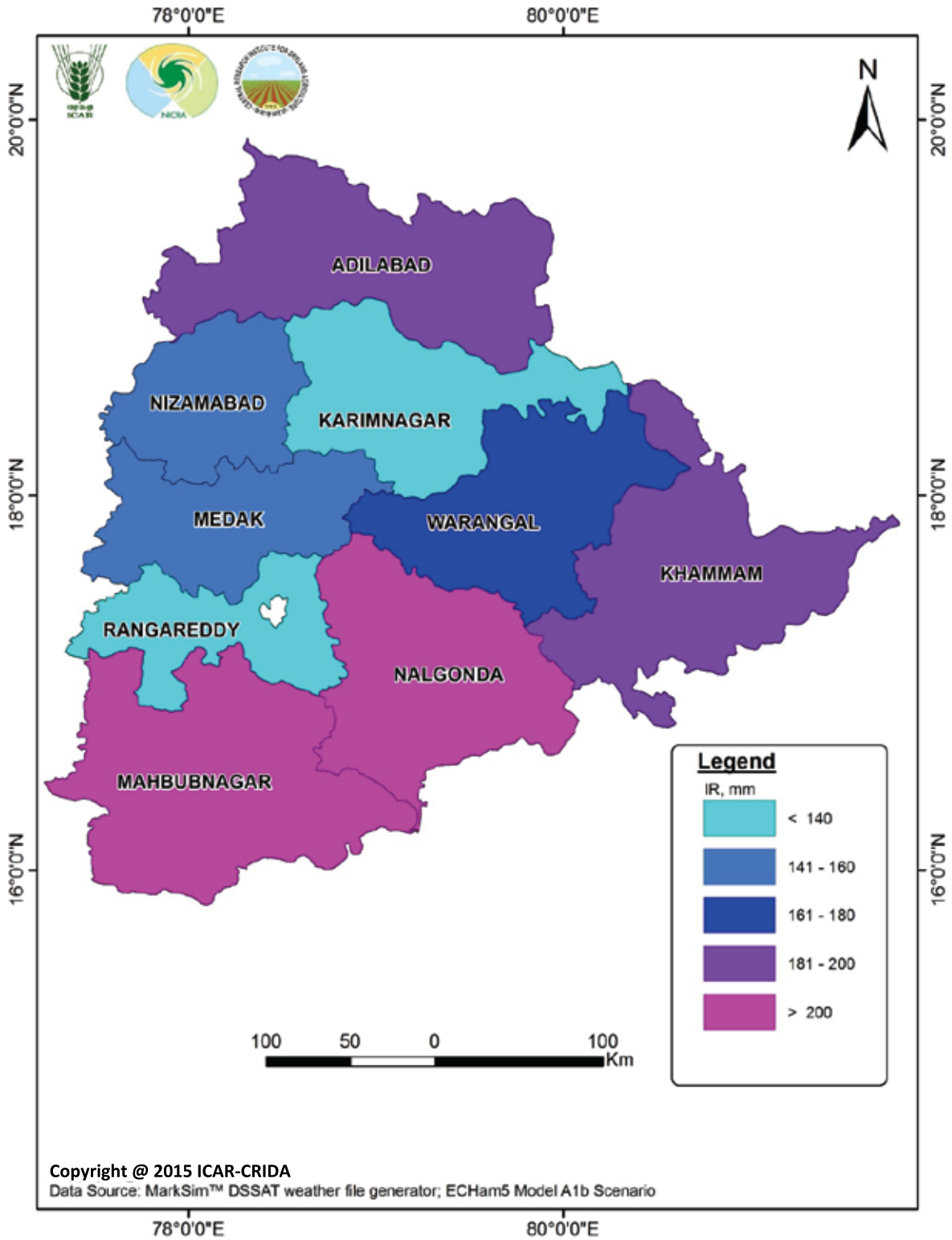

Fig.3.40 Irrigation requirement (IR) during crop growth period of cotton under late sowing for the decade 2041-2050 in Telangana

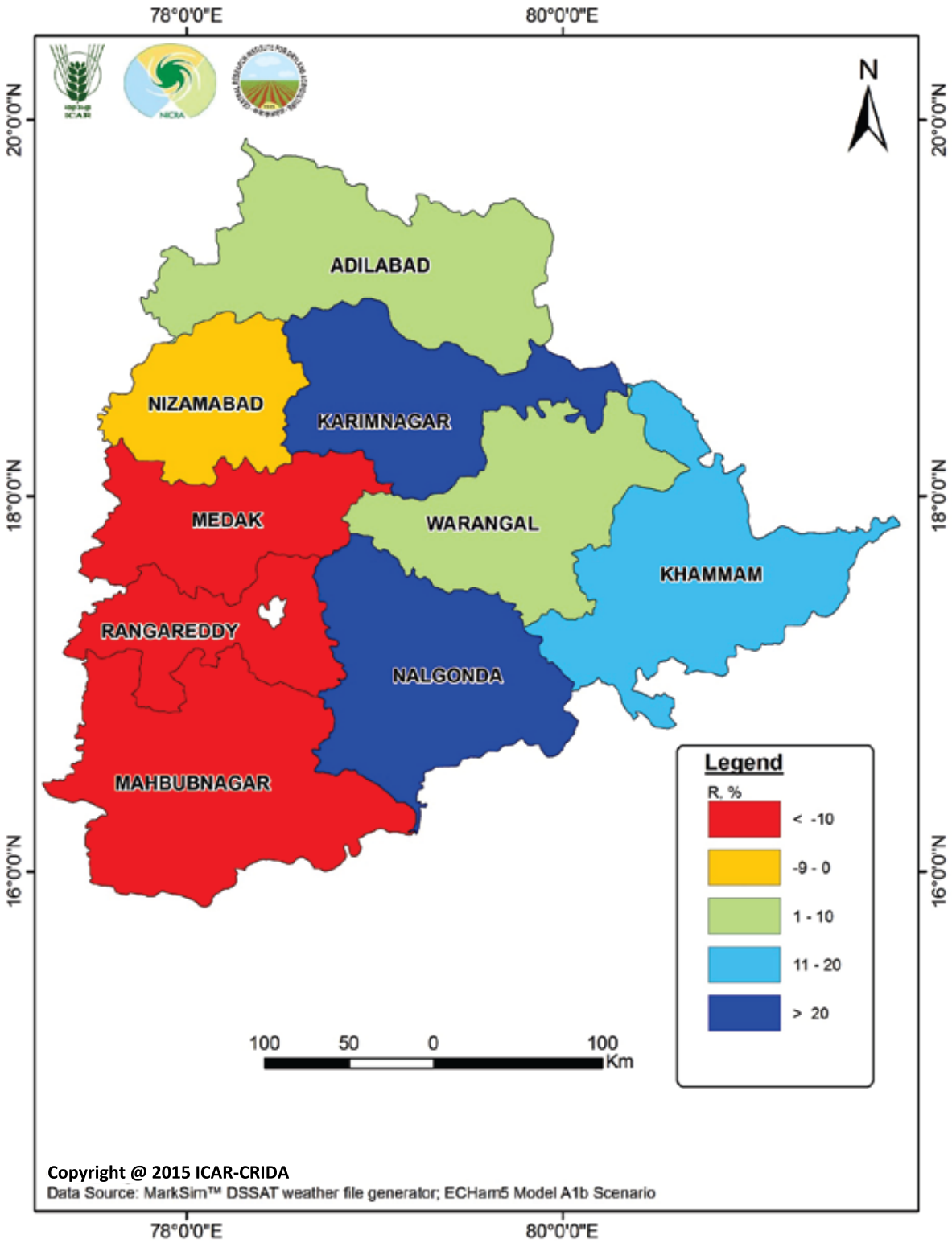

Fig.3.41 Percent decadal (2011-2020) deviation of rainfall (R) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

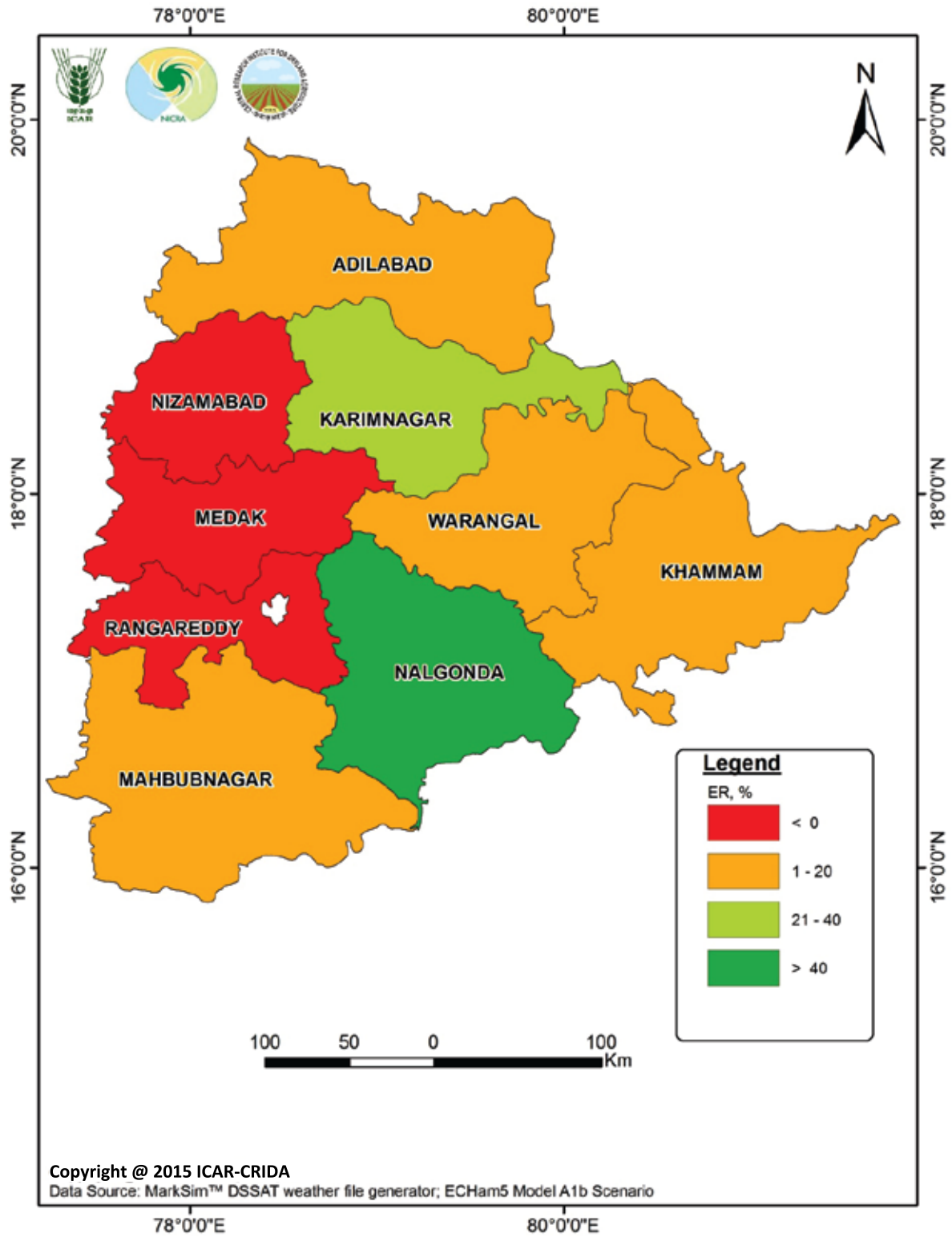

Fig.3.42 Percent decadal (2011-2020) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

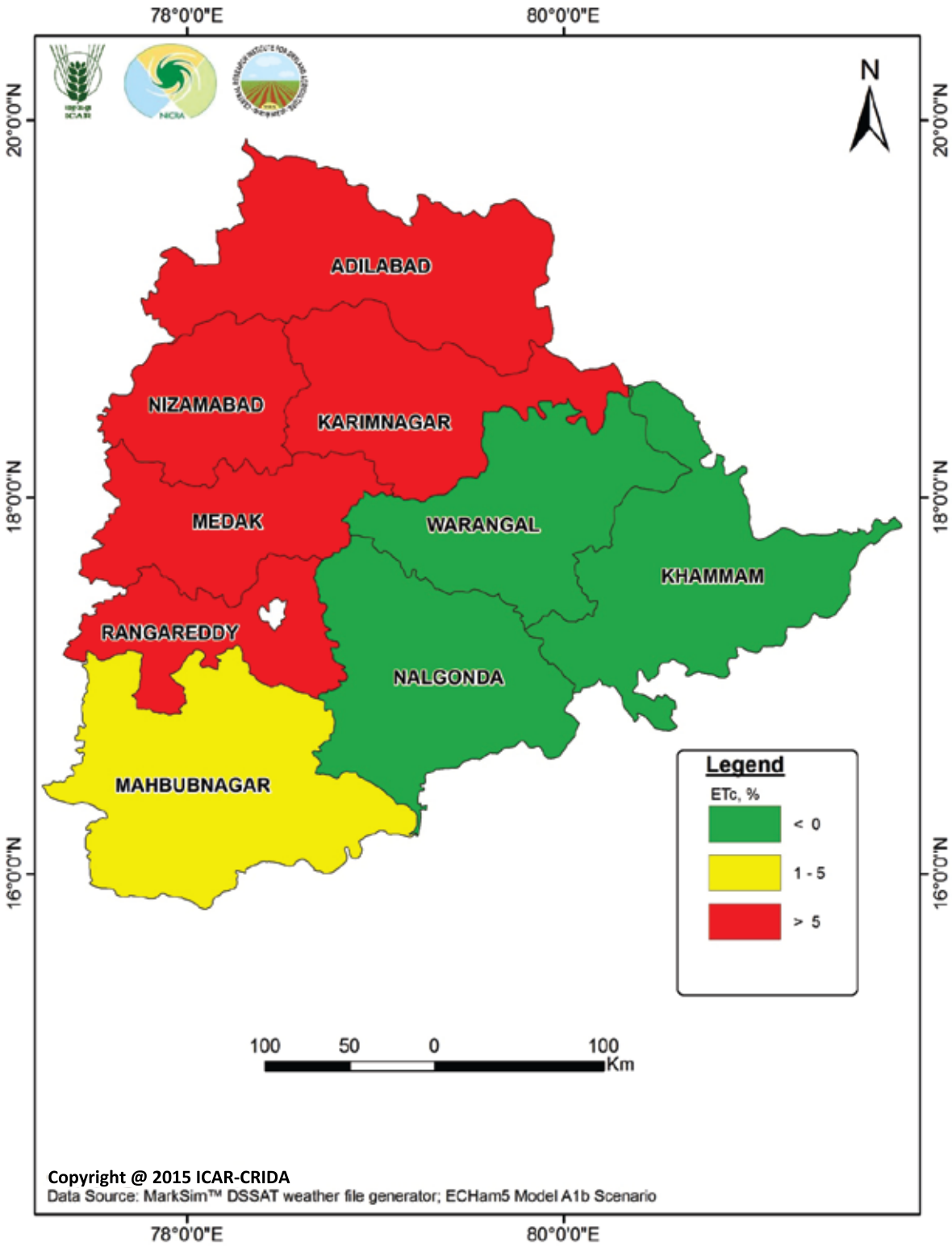

Fig.3.43 Percent decadal (2011-2020) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

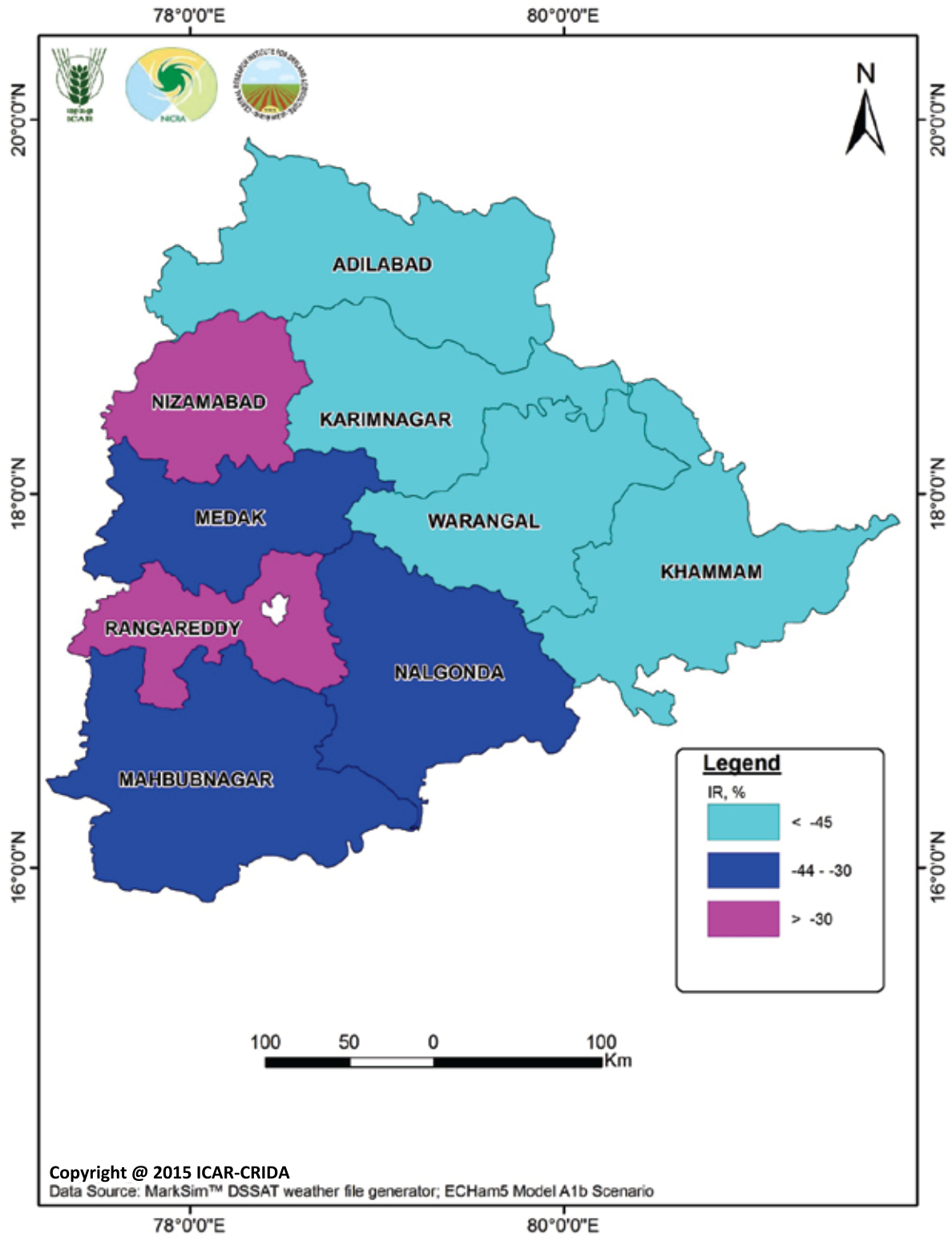

Fig.3.44 Percent decadal (2011-2020) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

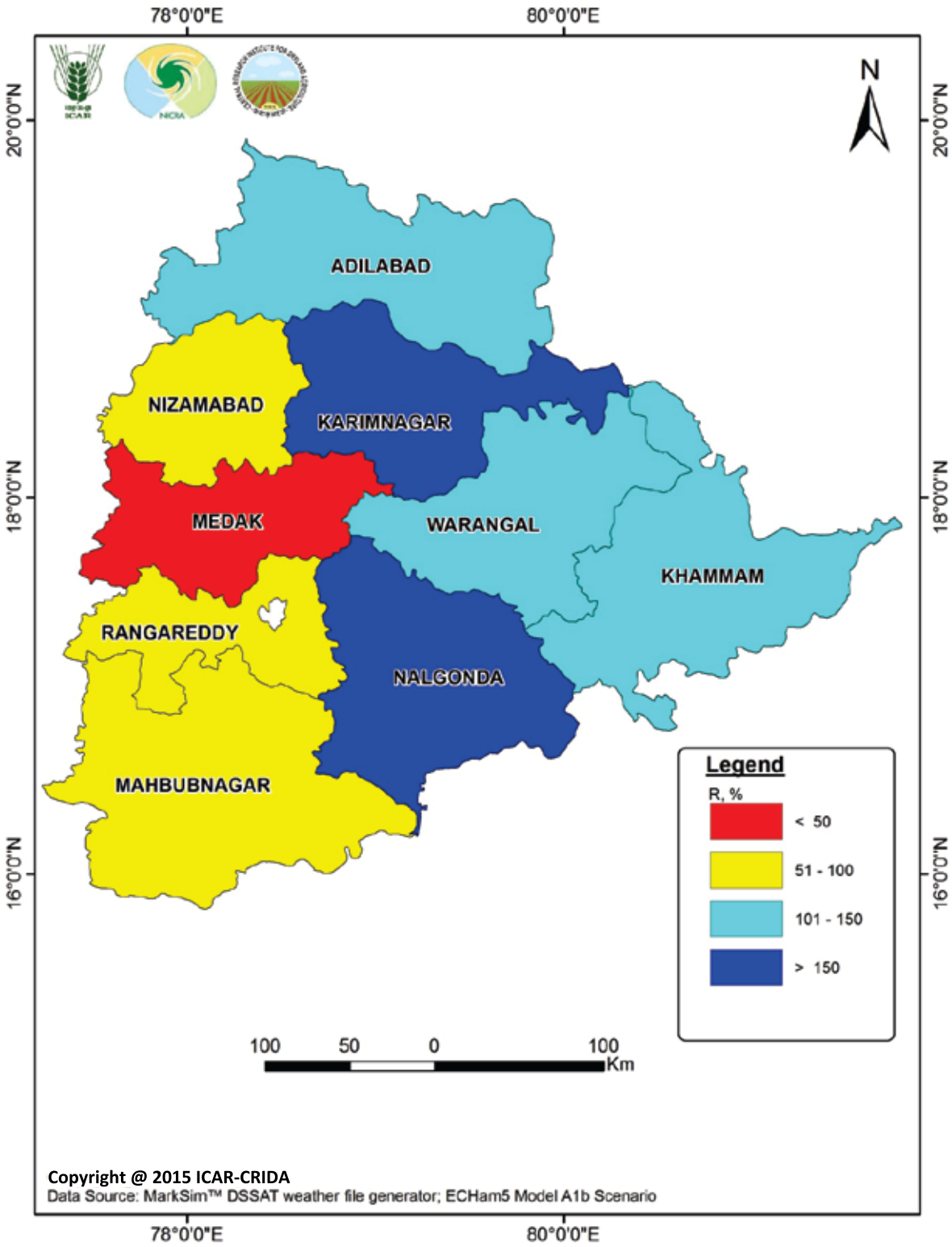

Fig.3.45 Percent decadal (2011-2020) deviation of rainfall (R) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

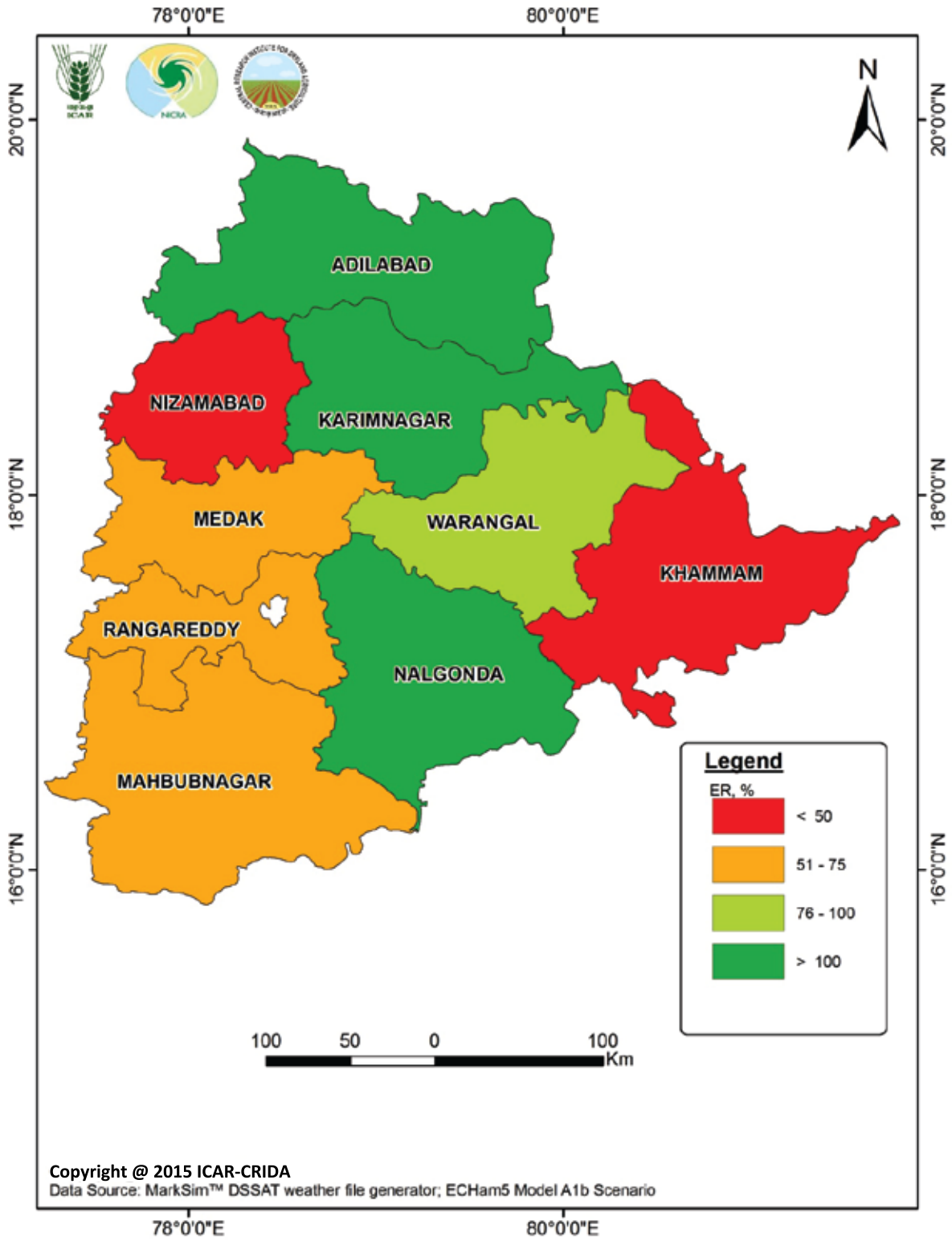

Fig.3.46 Percent decadal (2011-2020) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

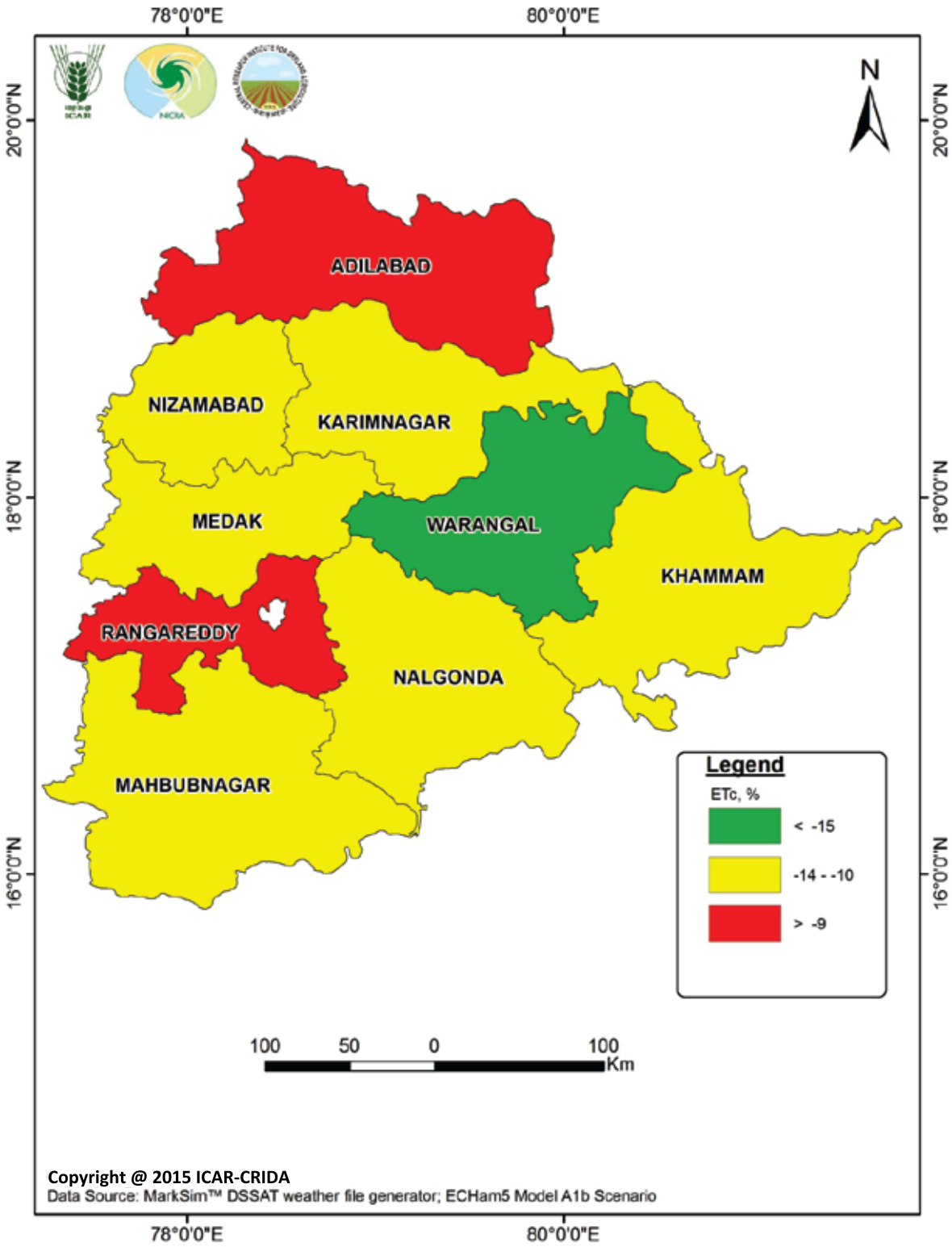

Fig.3.47 Percent decadal (2011-2020) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

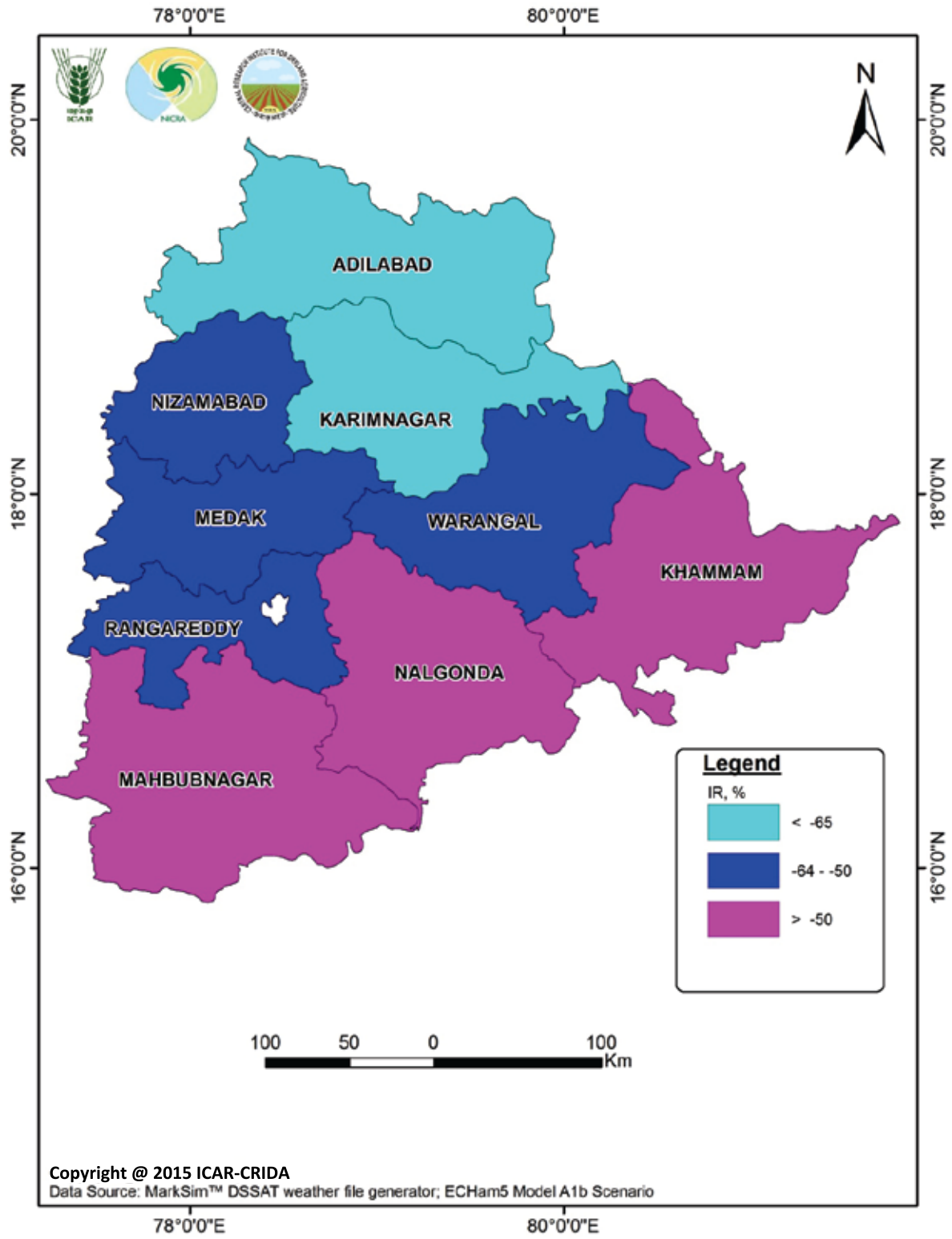

Fig.3.48 Percent decadal (2011-2020) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

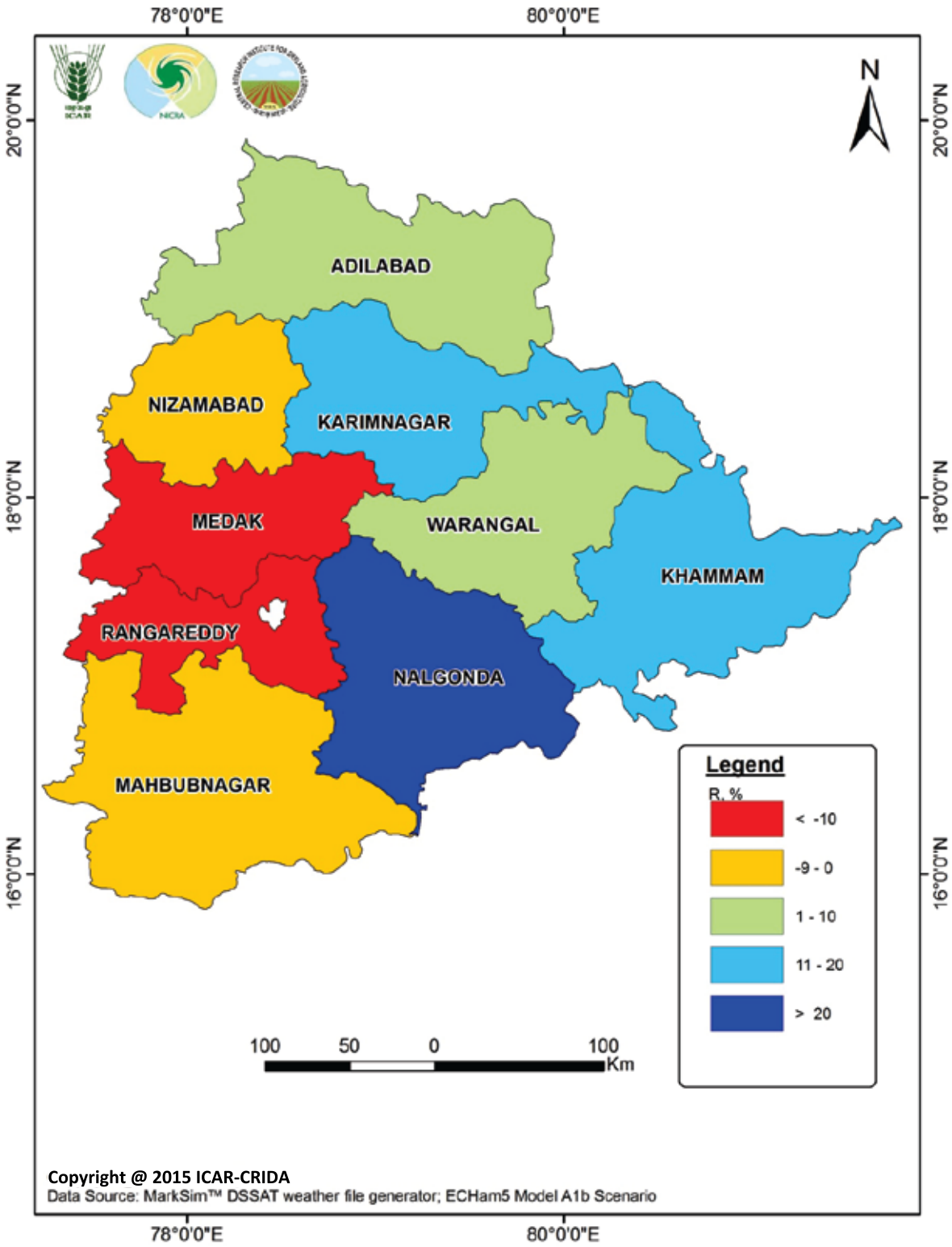

Fig.3.49 Percent decadal (2021-2030) deviation of rainfall (R) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

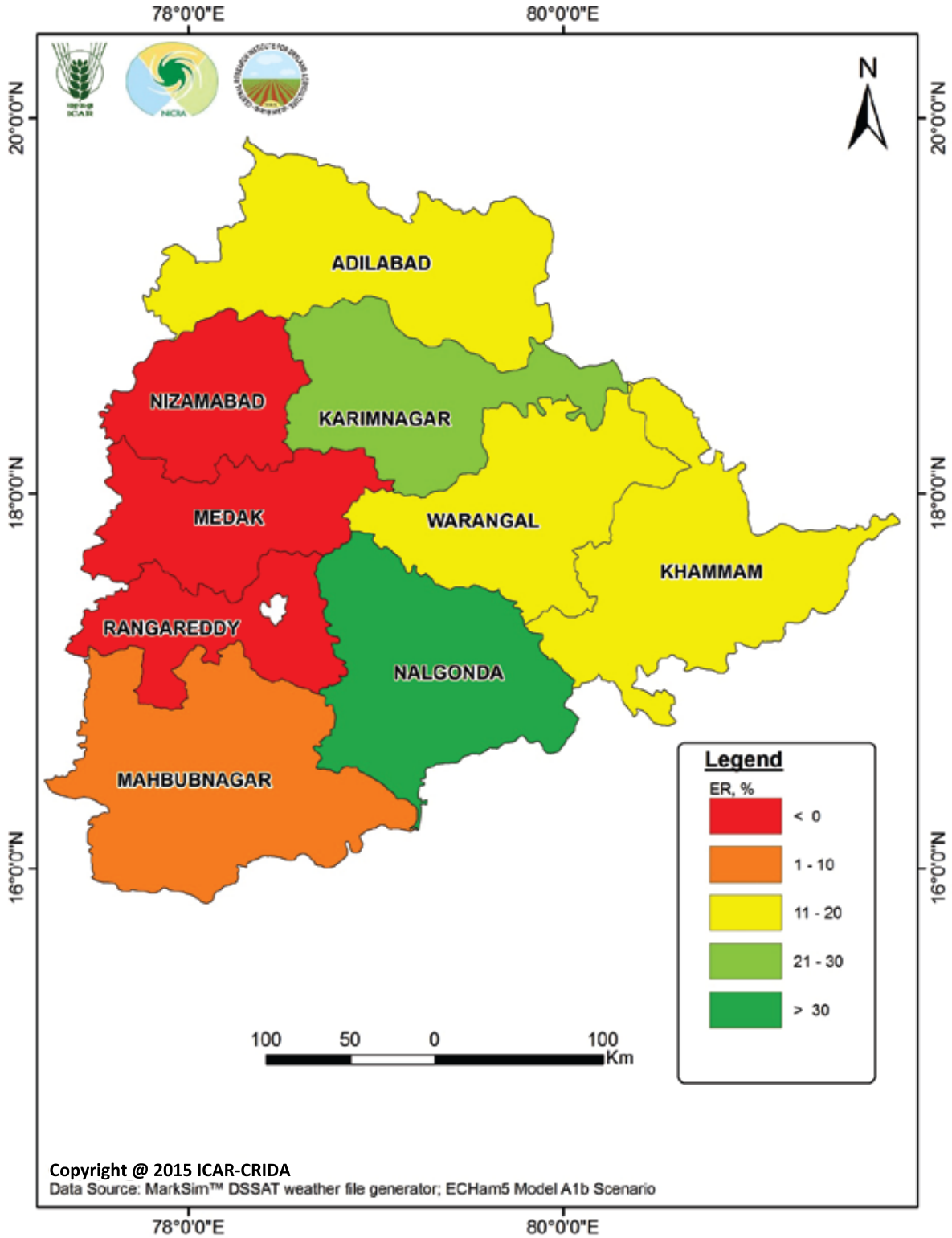

Fig.3.50 Percent decadal (2021-2030) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

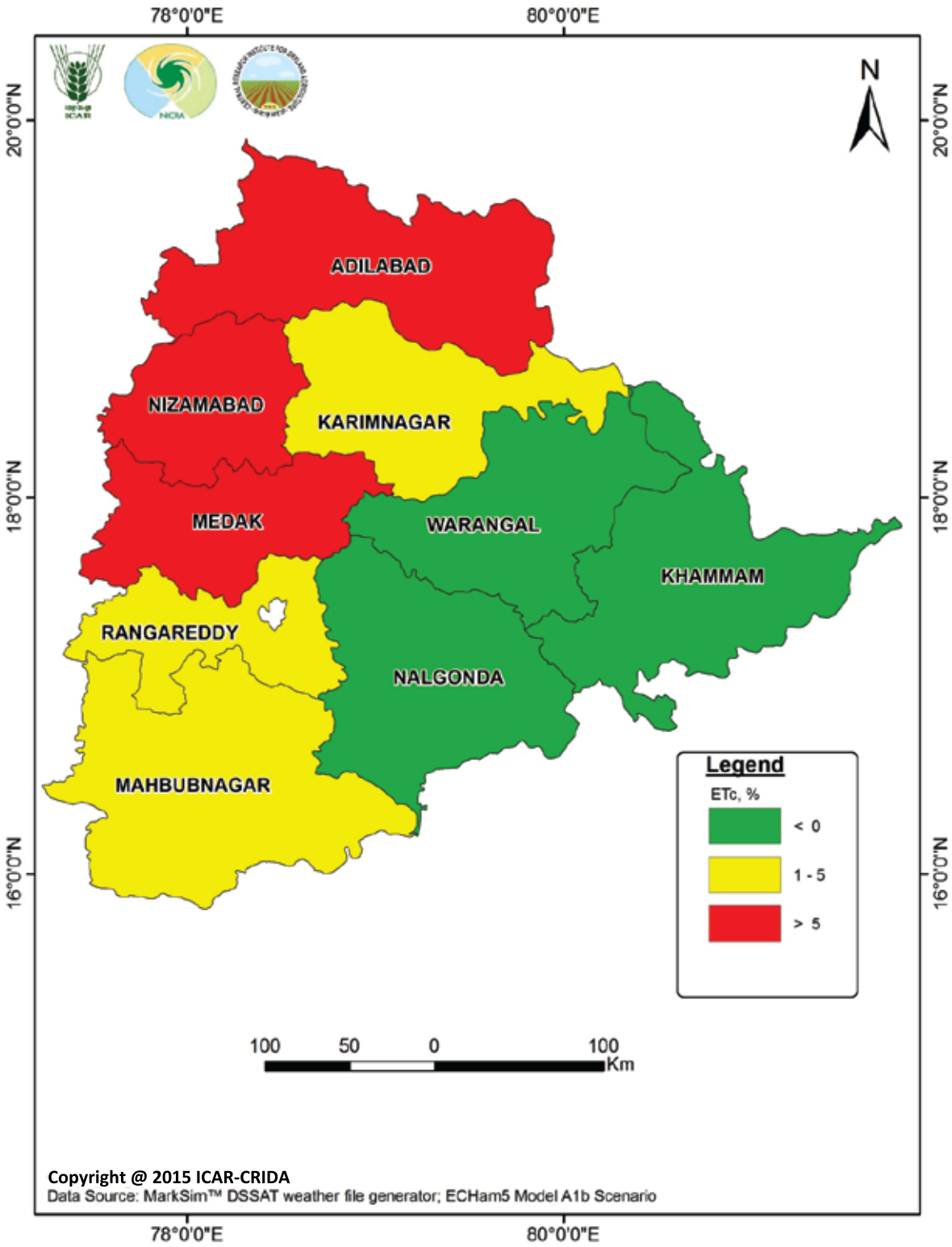

Fig.3.51 Percent decadal (2021-2030) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

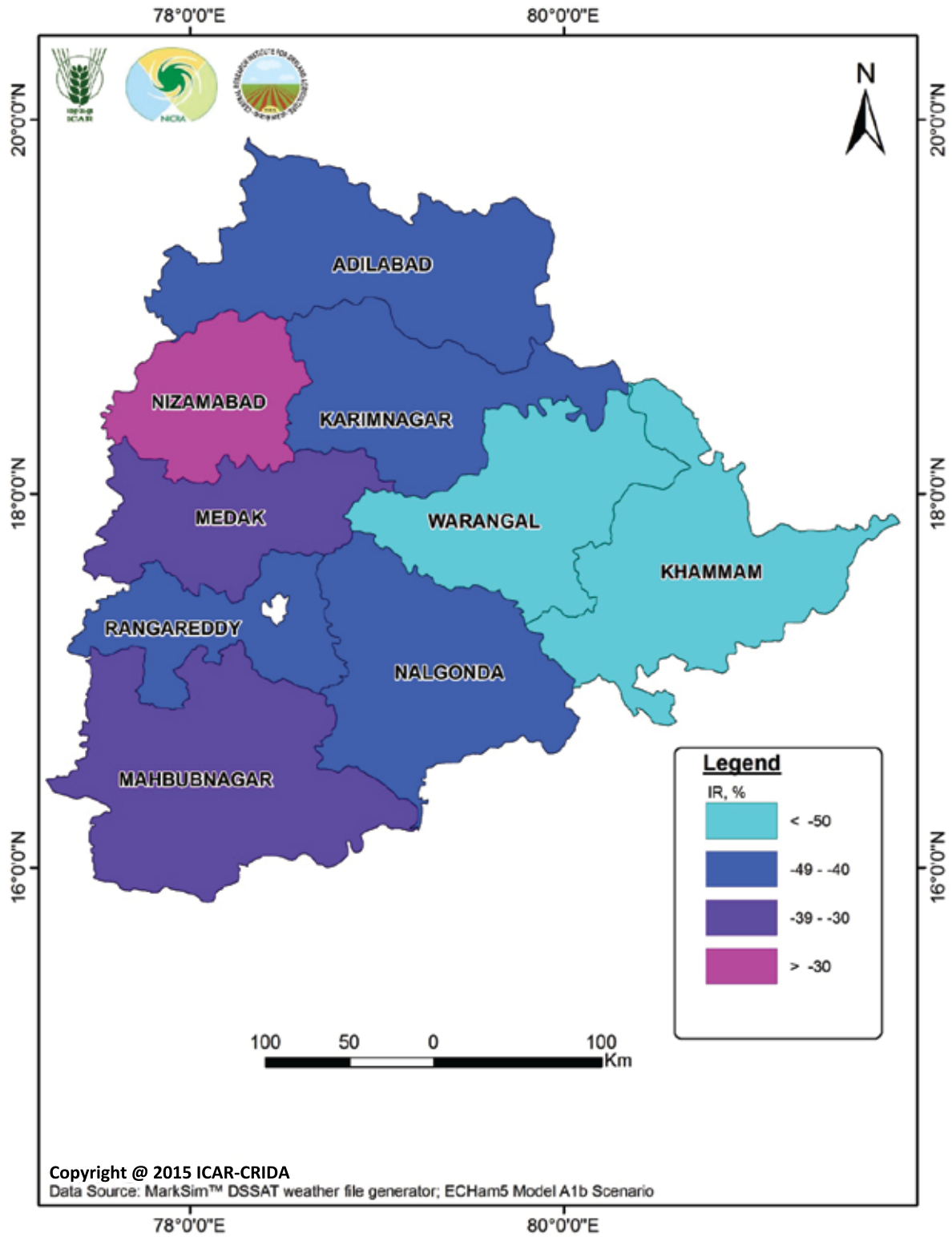

Fig.3.52 Percent decadal (2021-2030) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

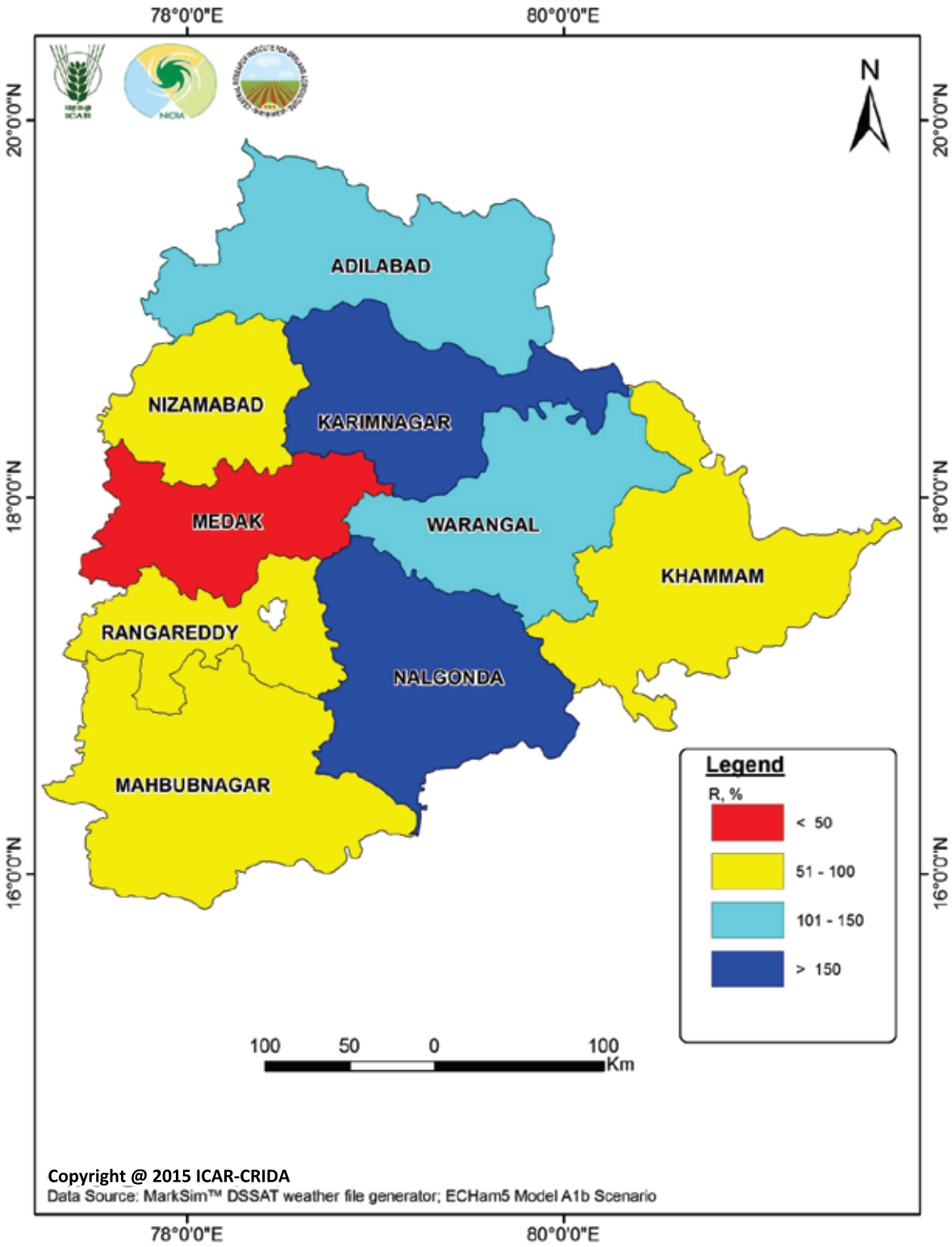

Fig.3.53 Percent decadal (2021-2030) deviation of rainfall (R) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

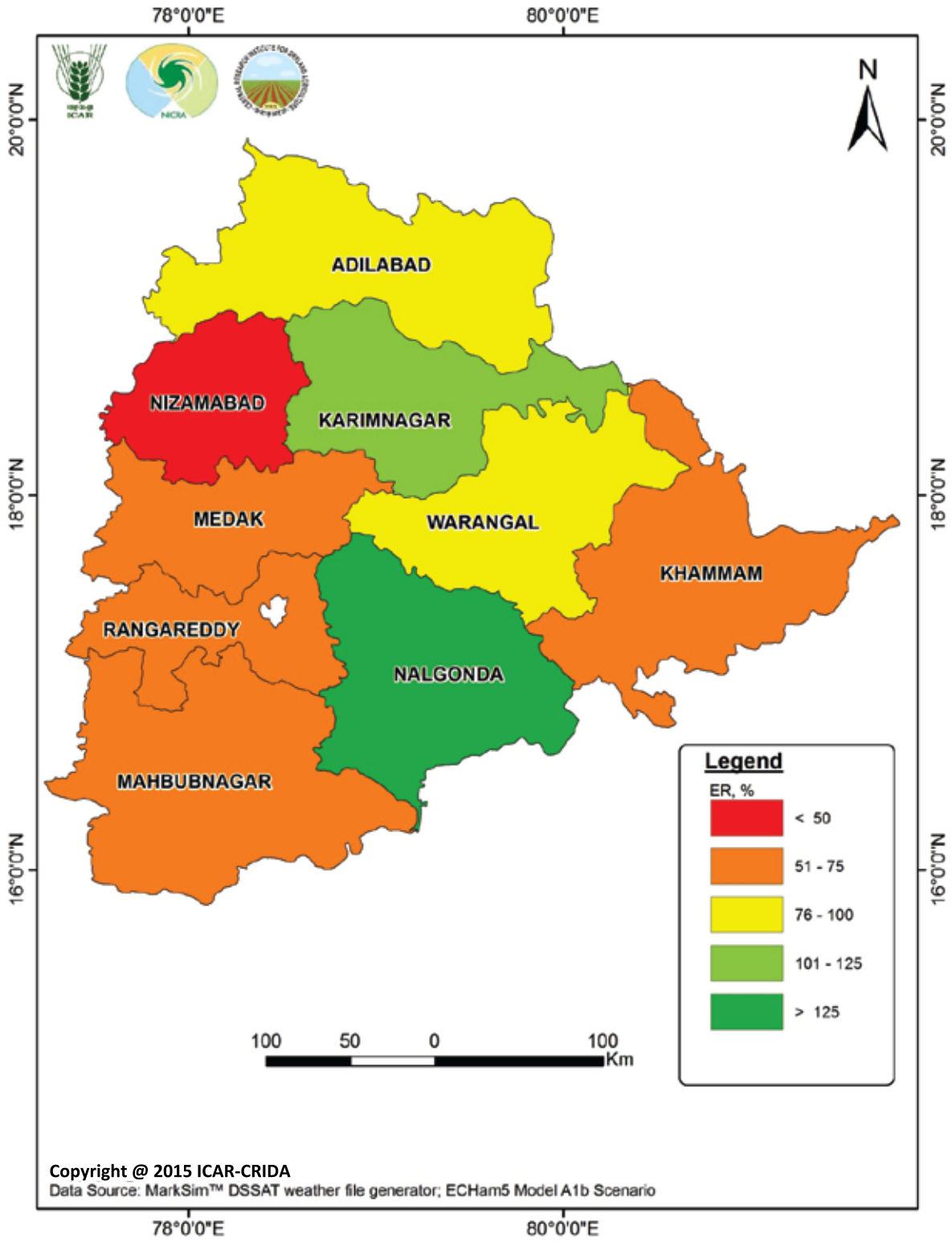

Fig.3.54 Percent decadal (2021-2030) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

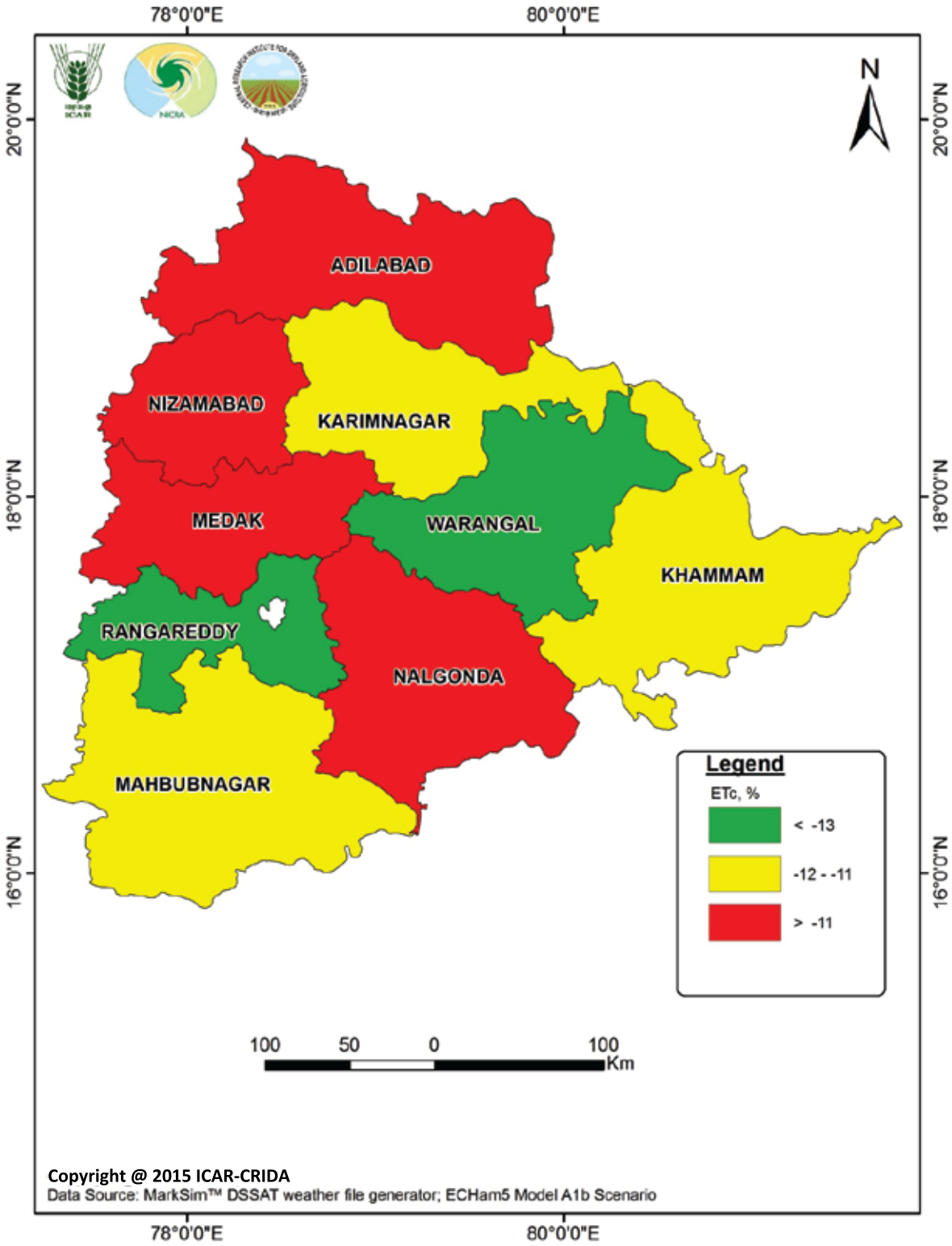

Fig.3.55 Percent decadal (2021-2030) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

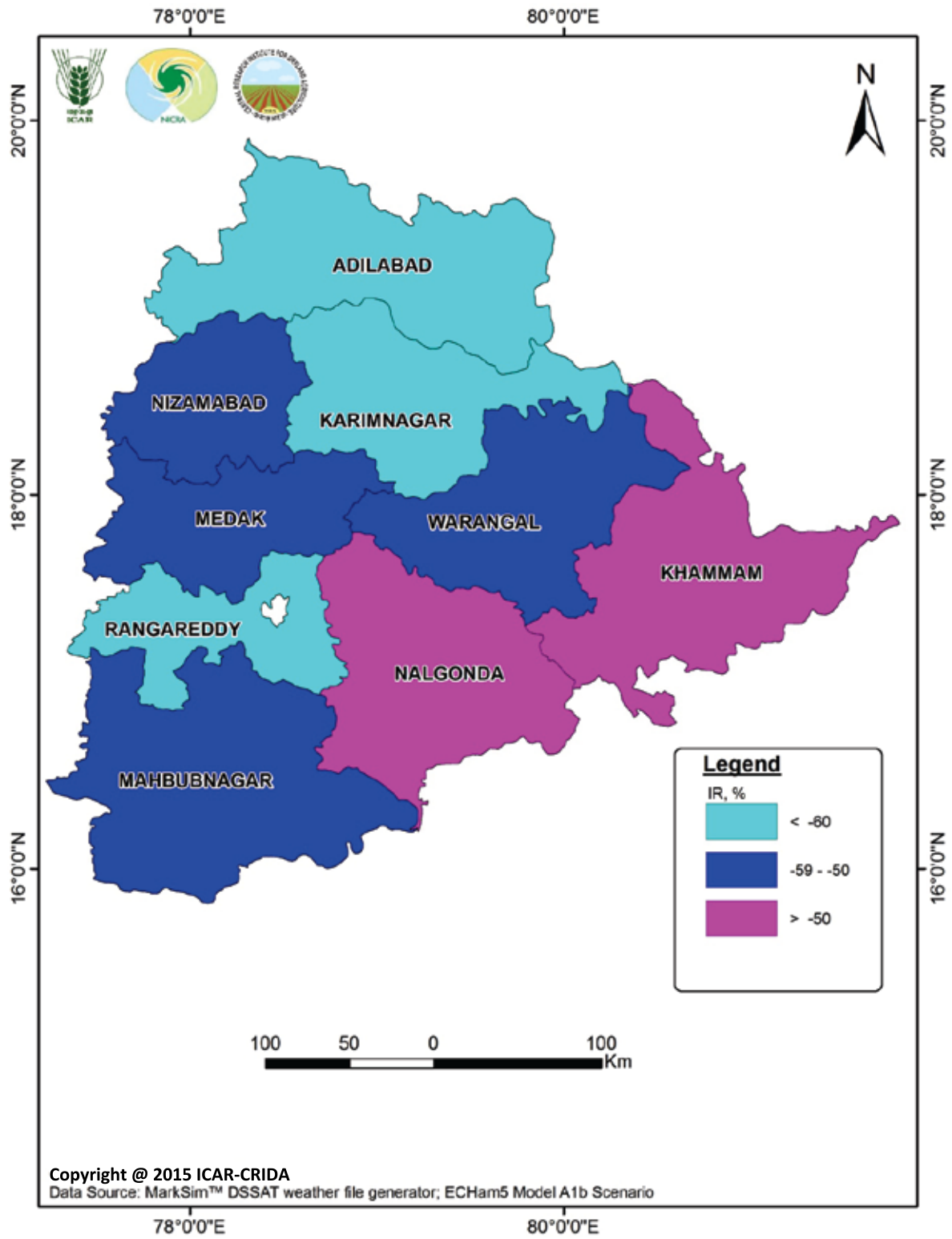

Fig.3.56 Percent decadal (2021-2030) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

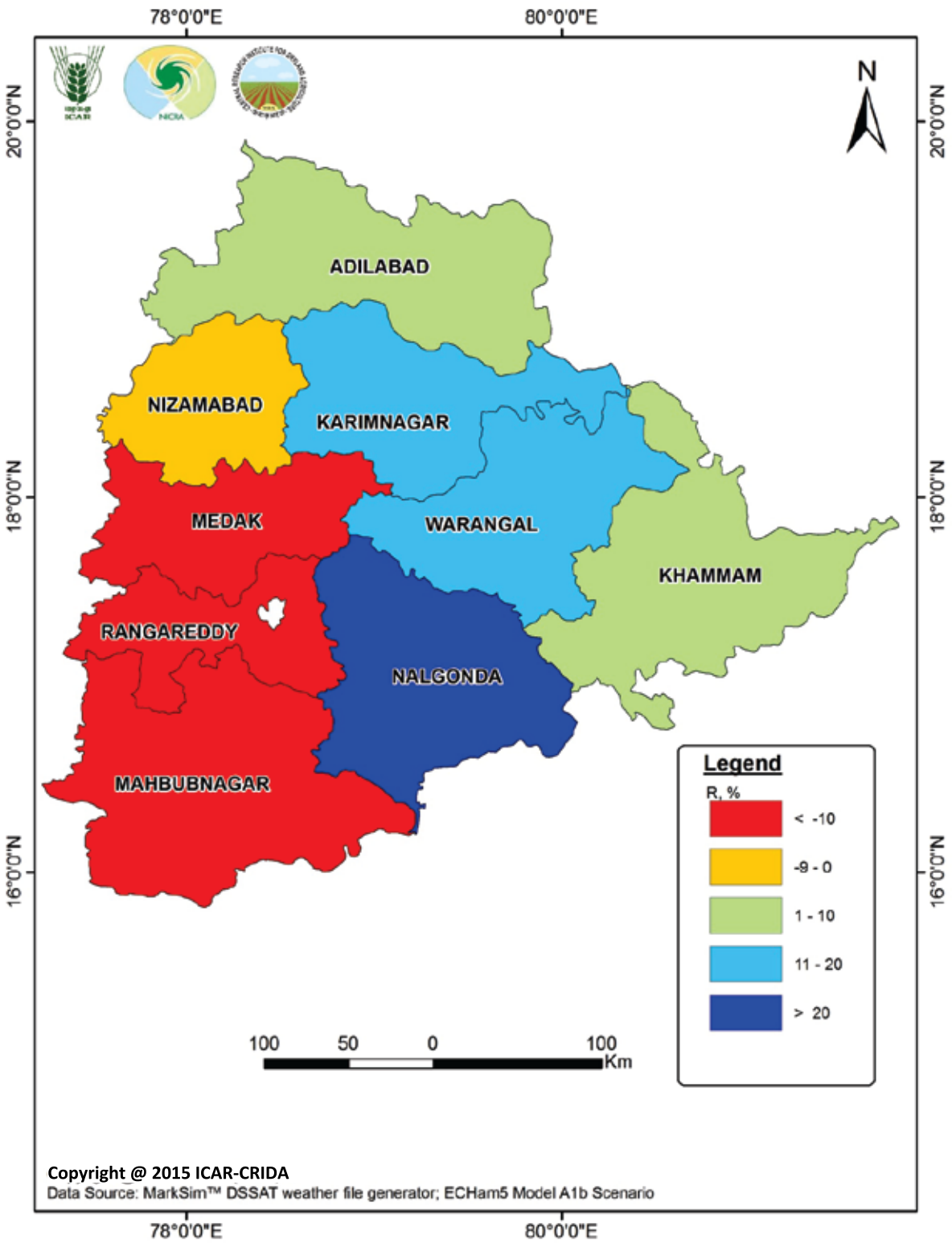

Fig.3.57 Percent decadal (2031-2040) deviation of rainfall (R) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

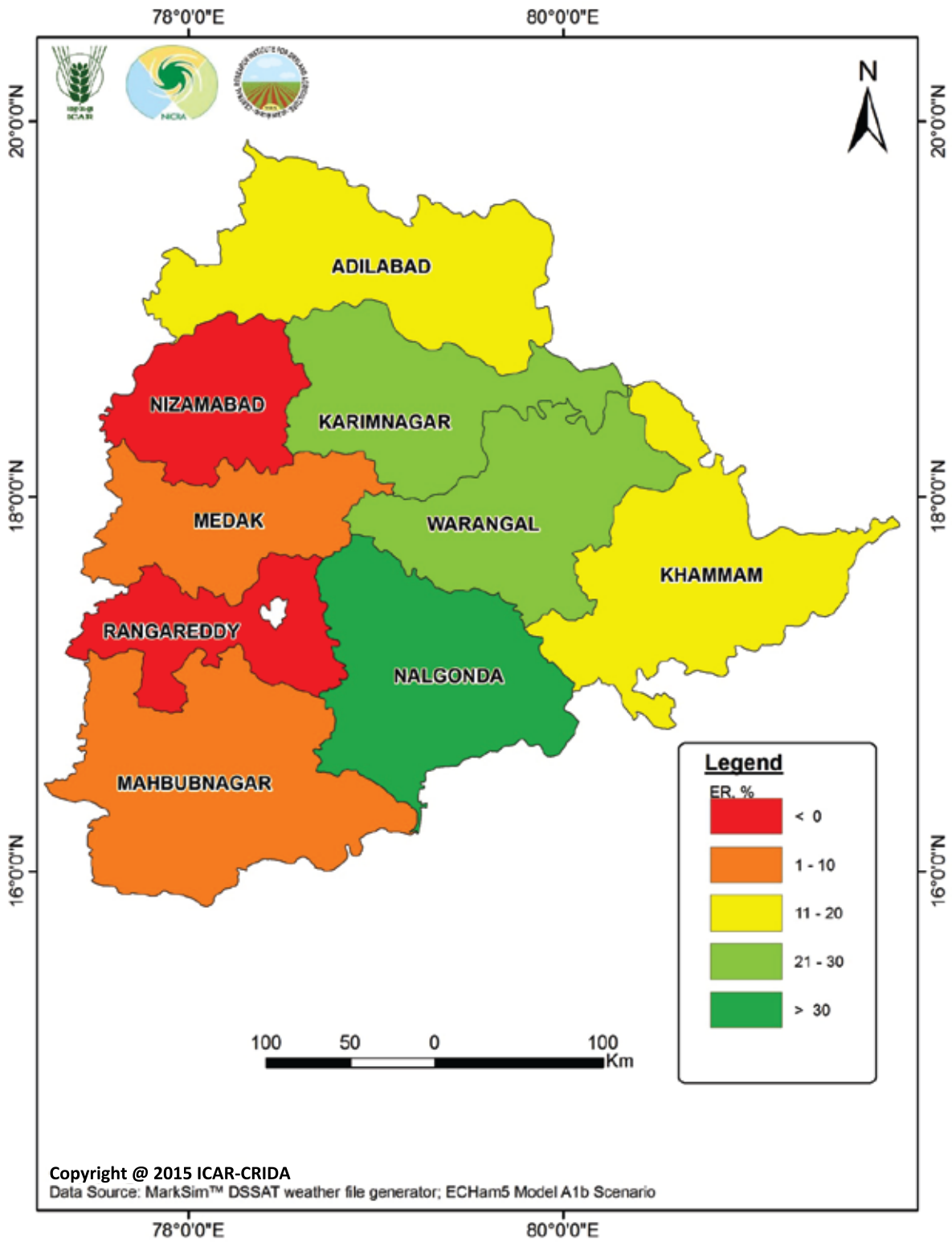

Fig.3.58 Percent decadal (2031-2040) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

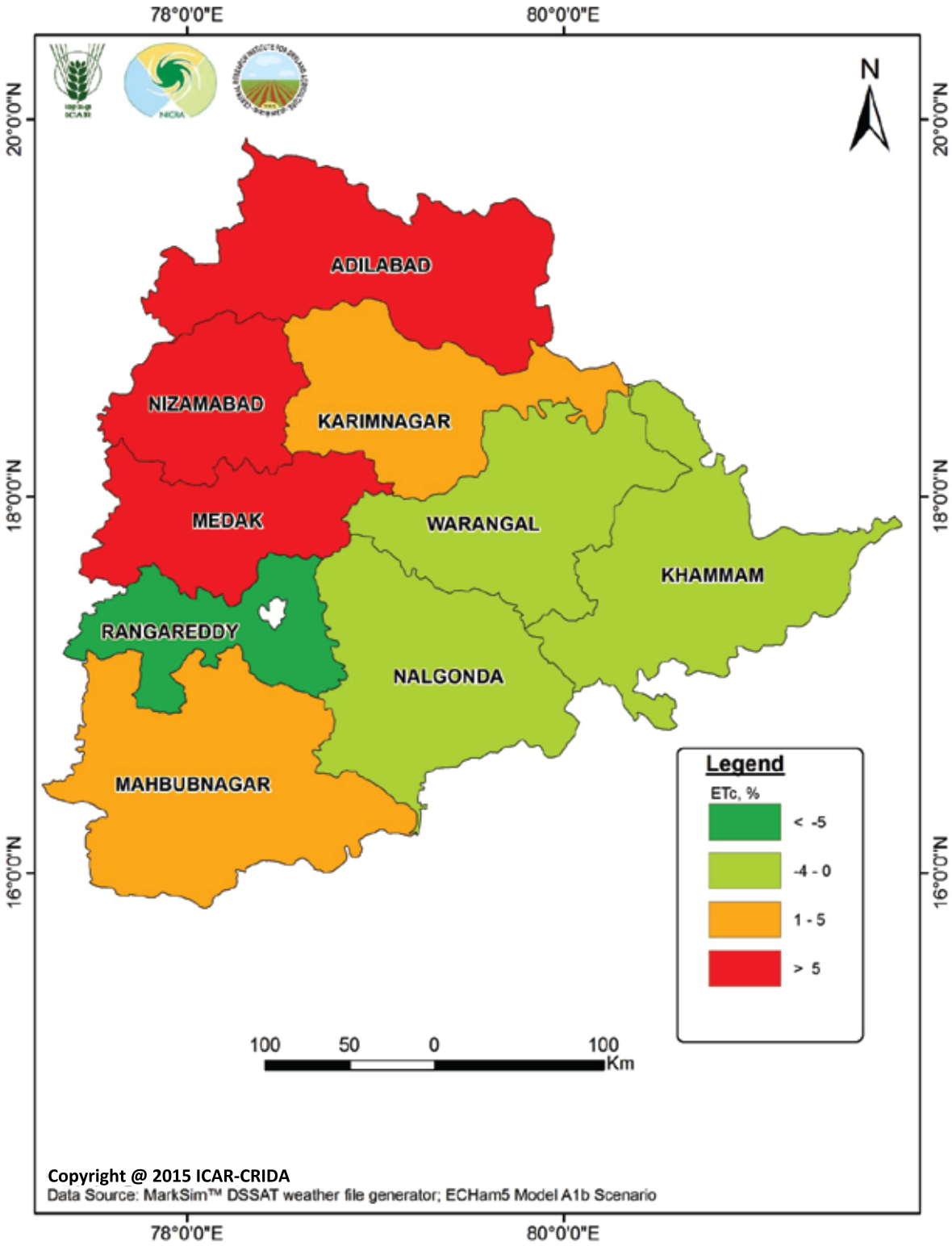

Fig.3.59 Percent decadal (2031-2040) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

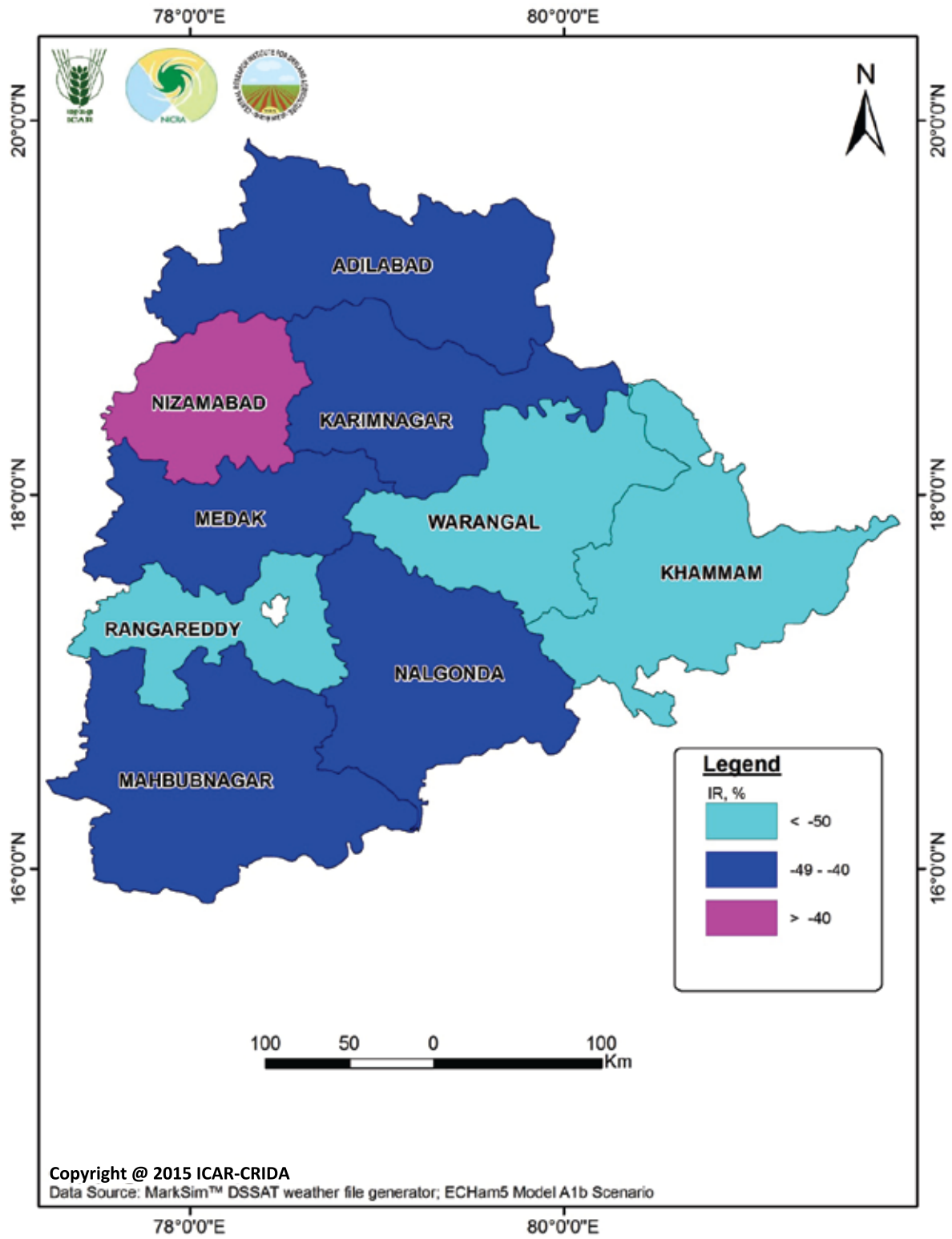

Fig.3.60 Percent decadal (2031-2040) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

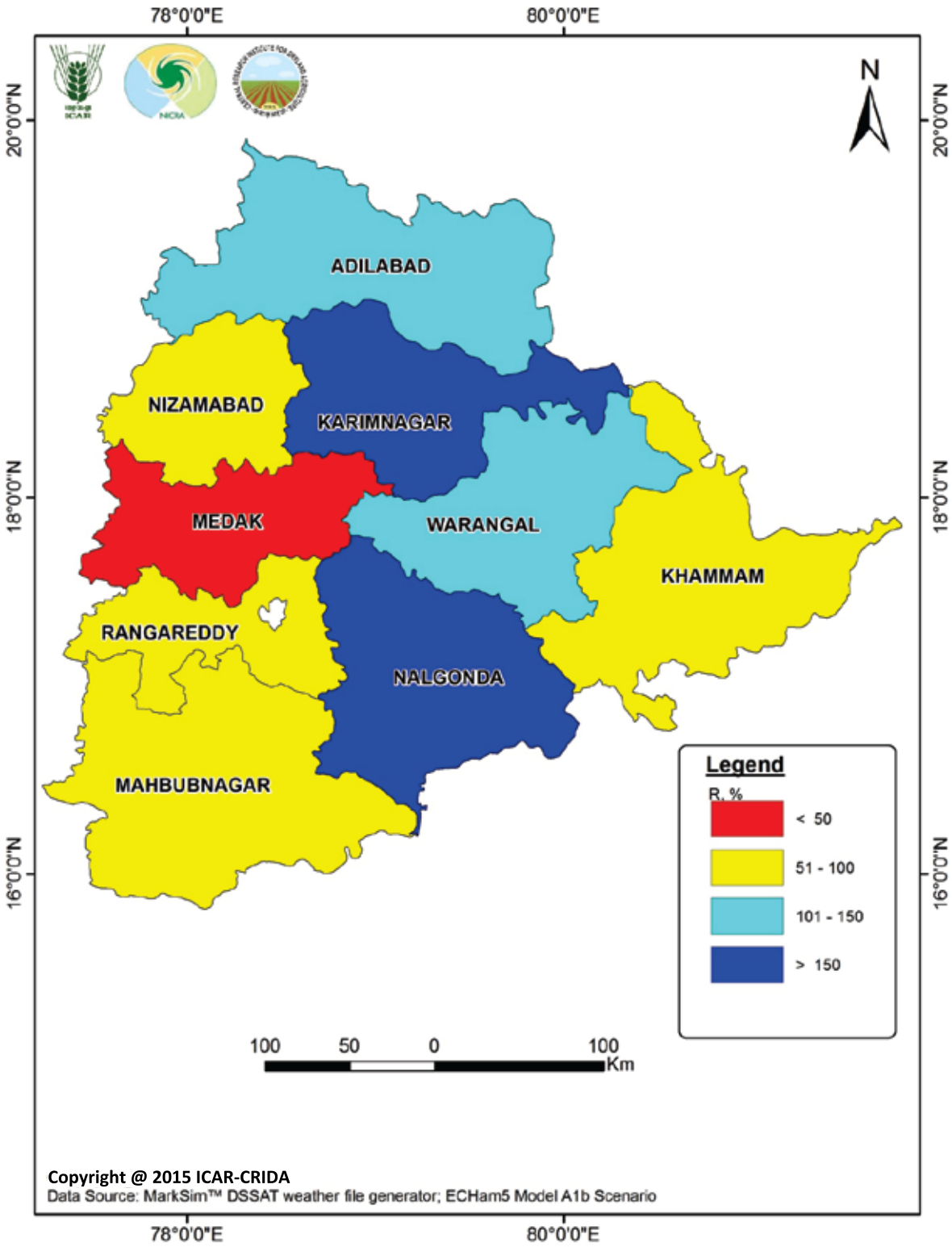

Fig.3.61Percent decadal (2031-2040) deviation of rainfall (R) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

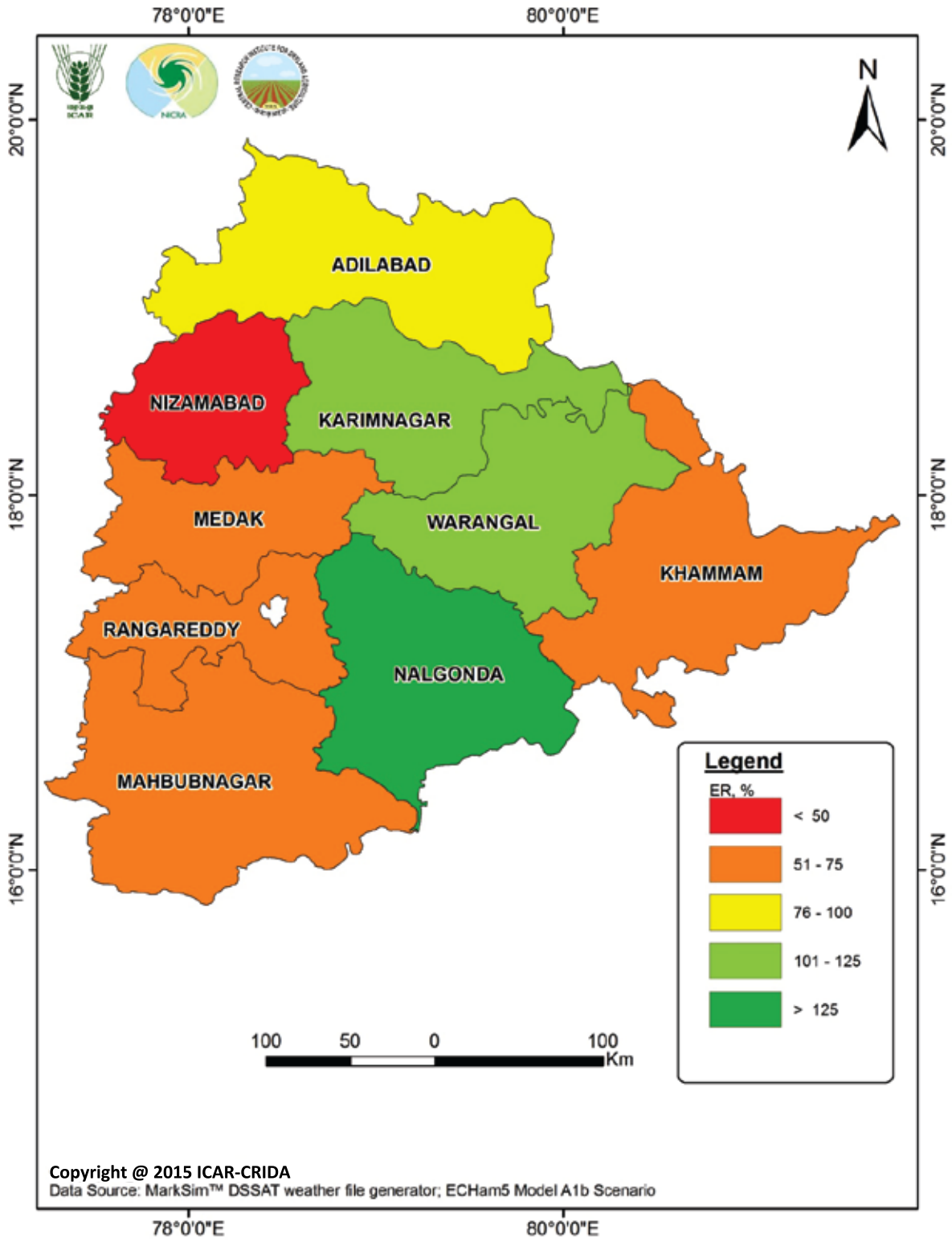

Fig.3.62 Percent decadal (2031-2040) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

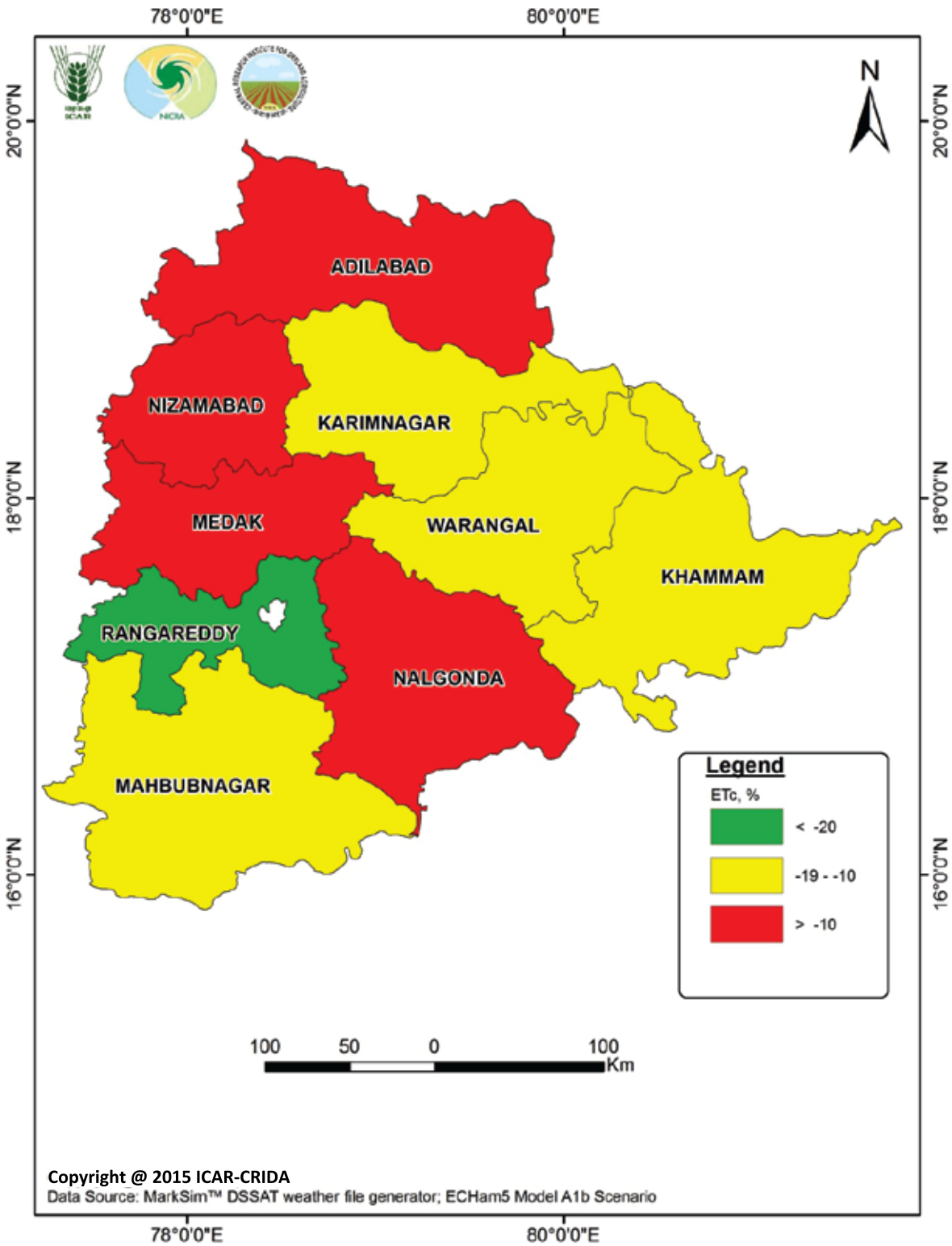

Fig.3.63 Percent decadal (2031-2040) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

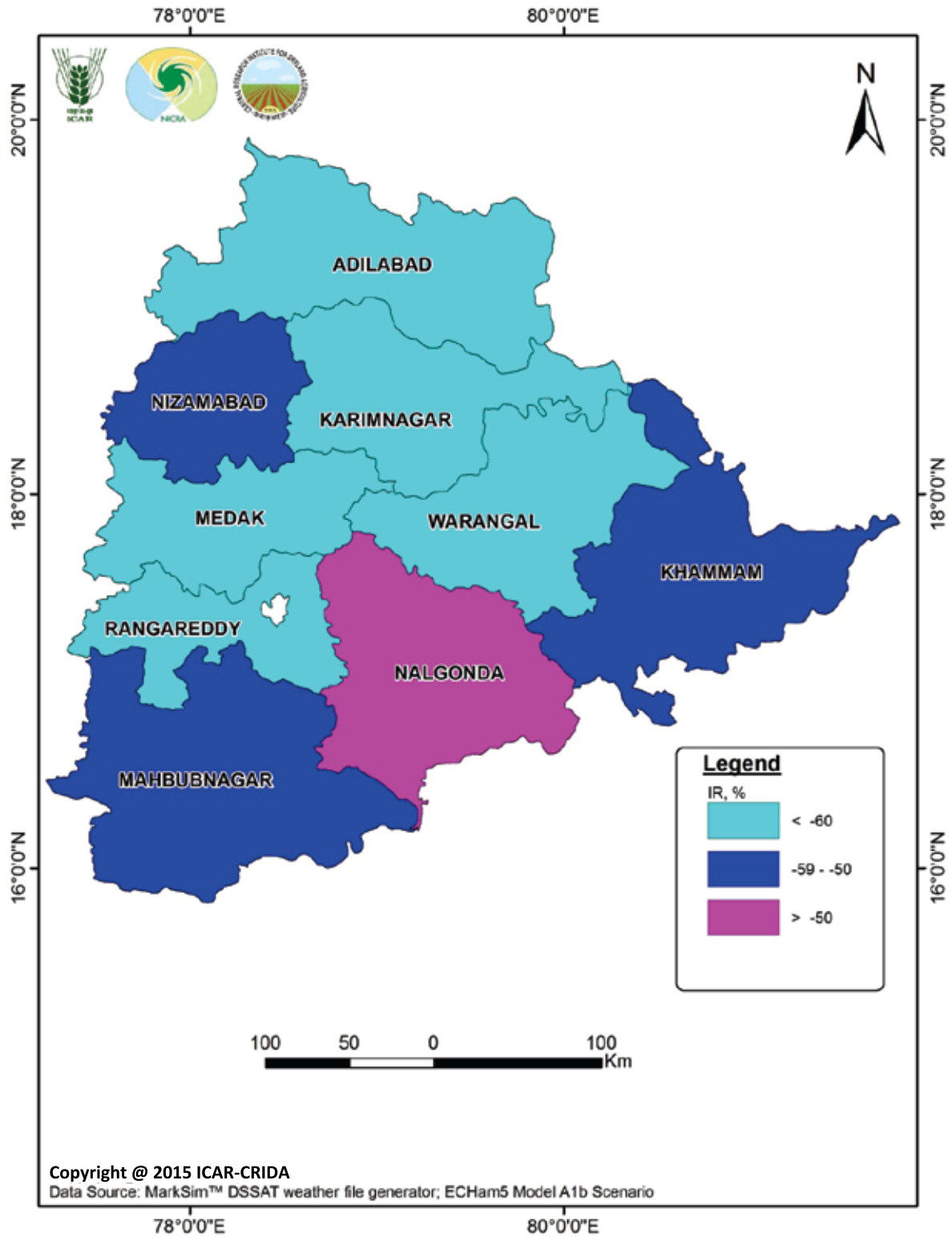

Fig.3.64 Percent decadal (2031-2040) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

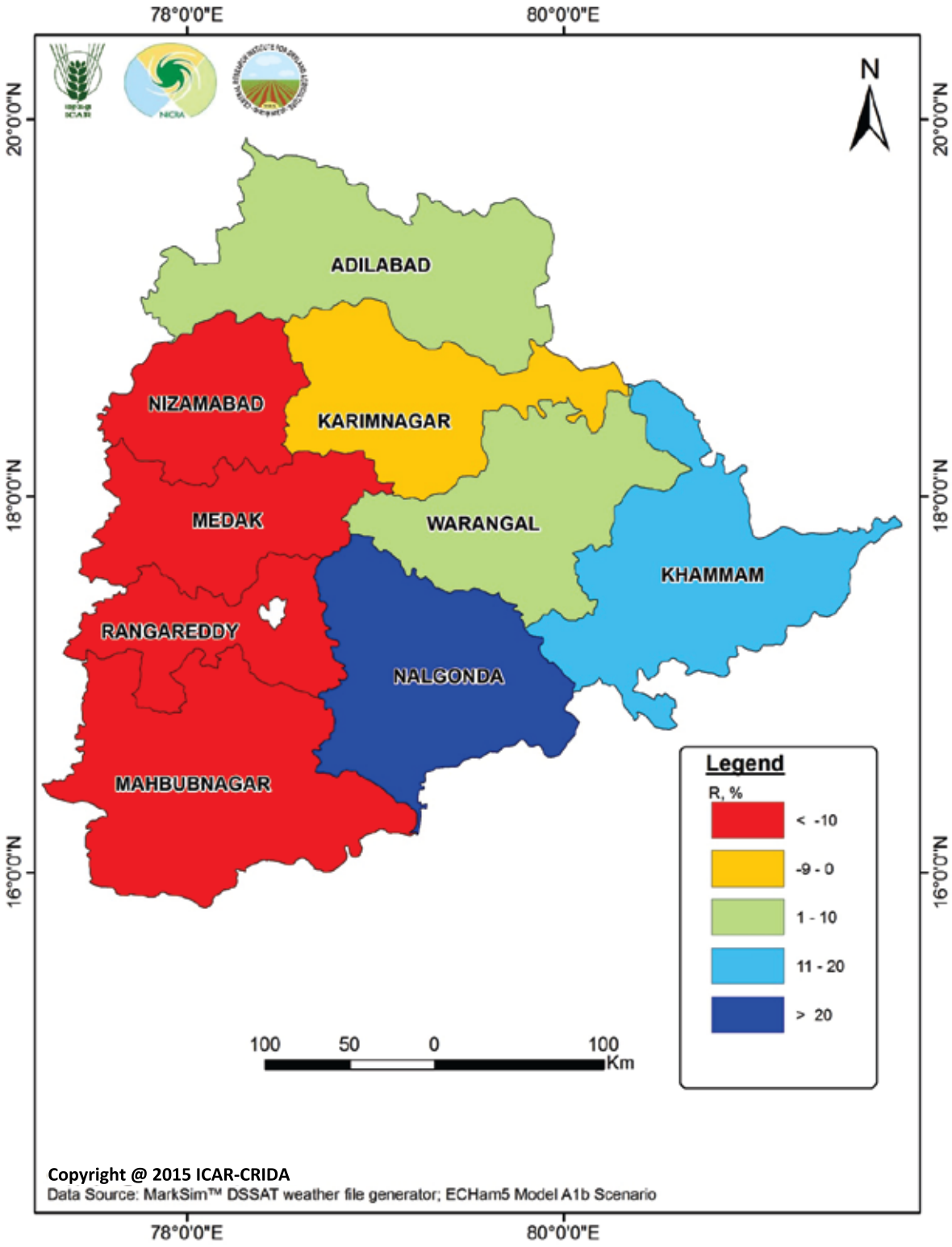

Fig.3.65 Percent decadal (2041-2050) deviation of rainfall (R) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

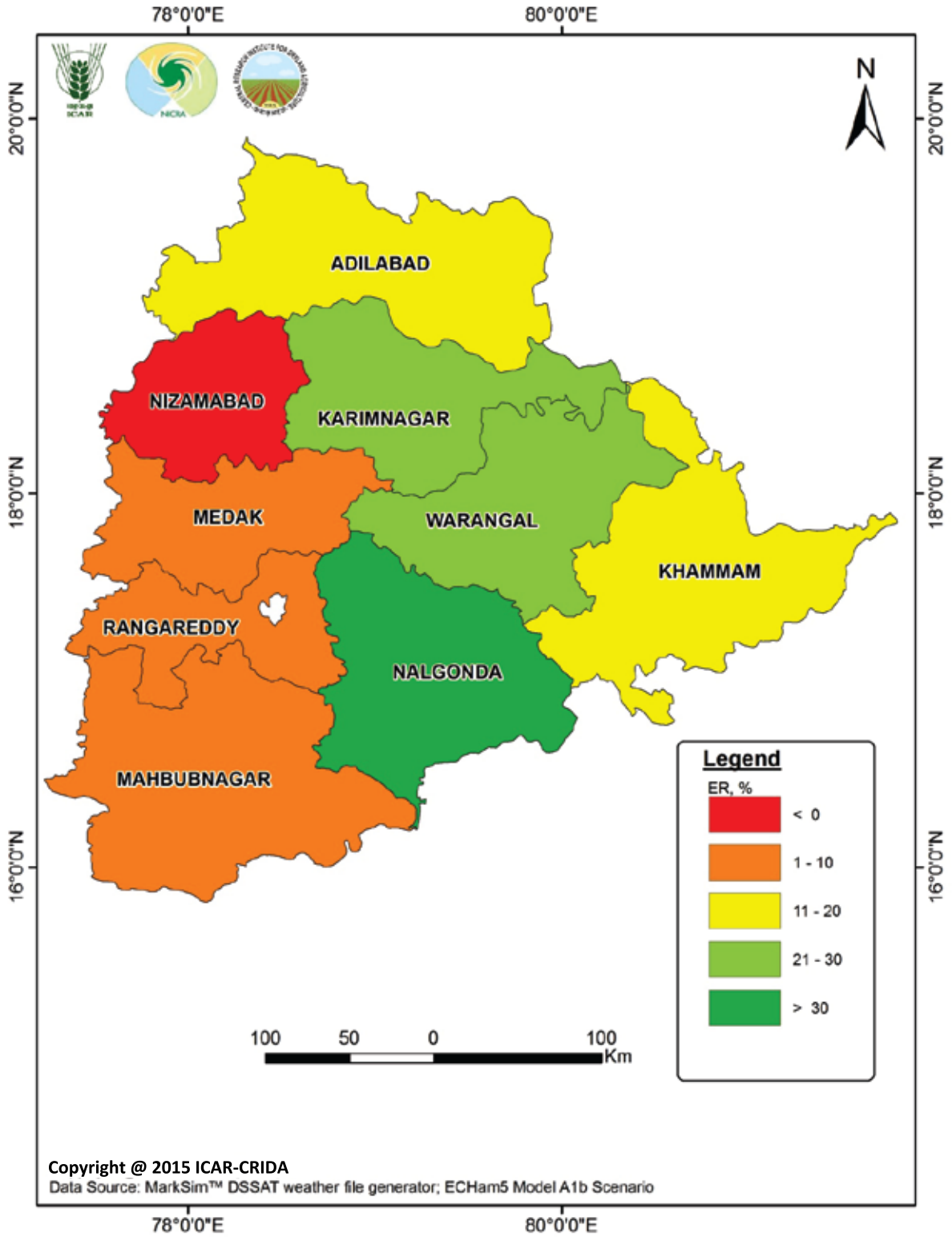

Fig.3.66 Percent decadal (2041-2050) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

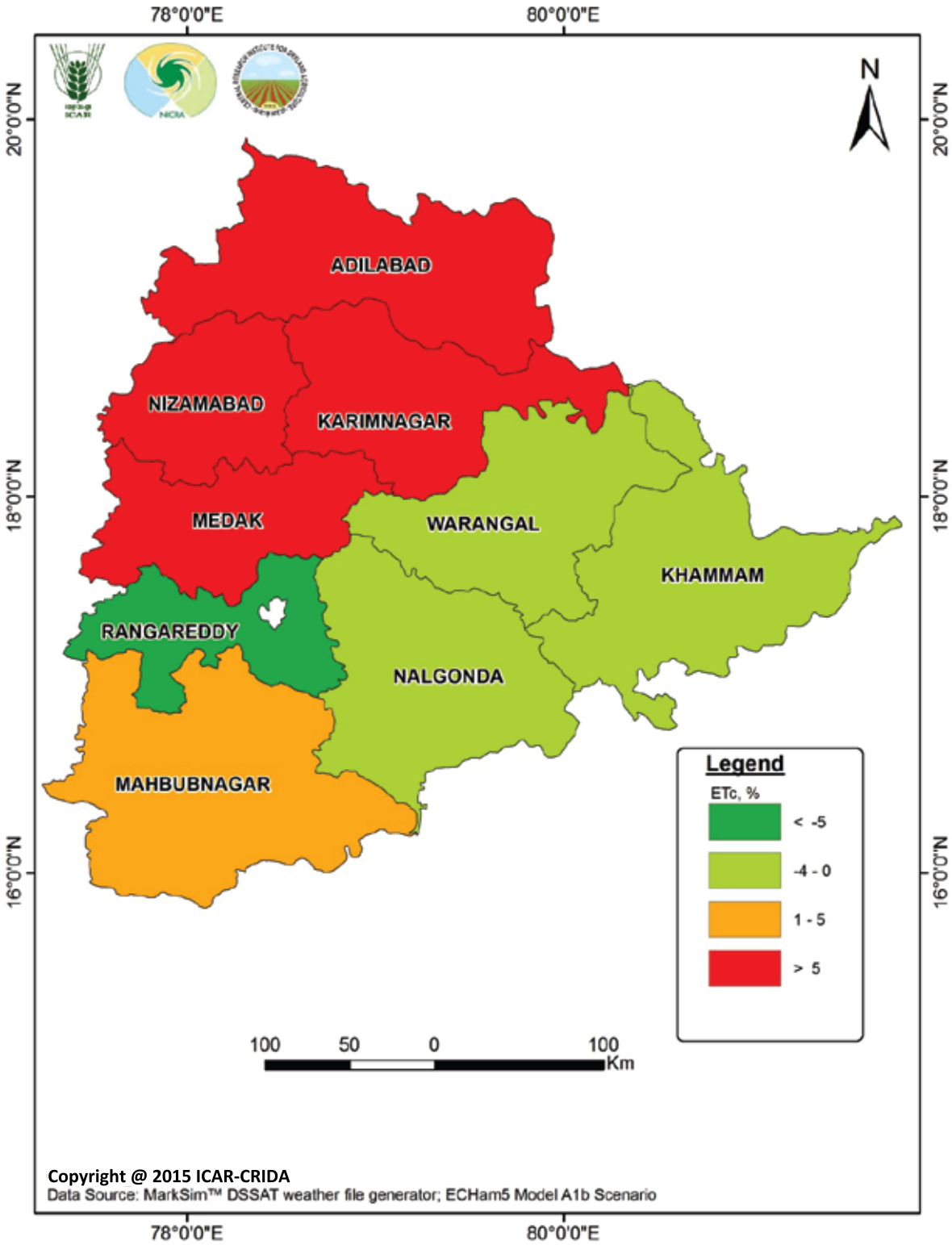

Fig.3.67 Percent decadal (2041-2050) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

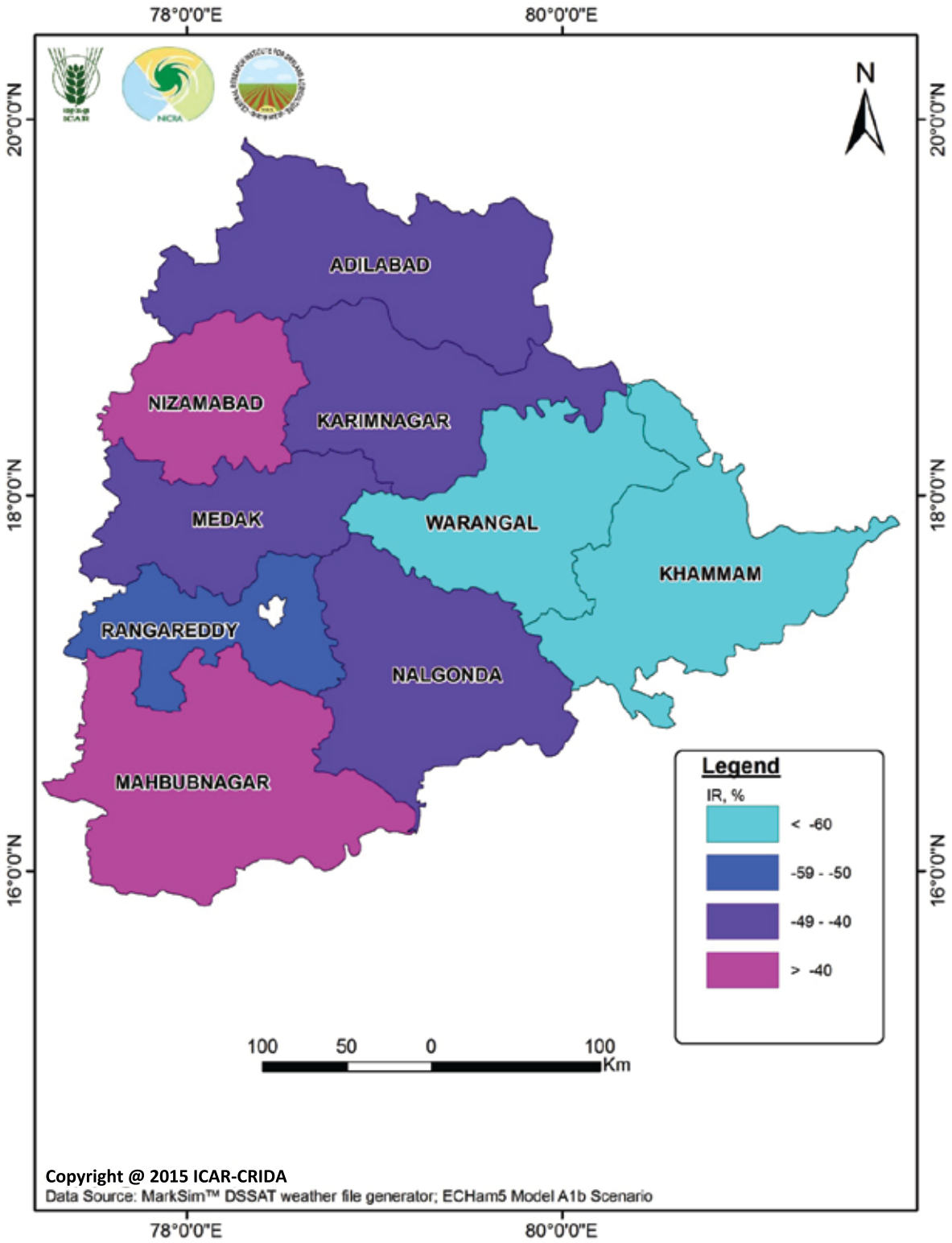

Fig.3.68 Percent decadal (2041-2050) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of cotton under normal sowing in Telangana

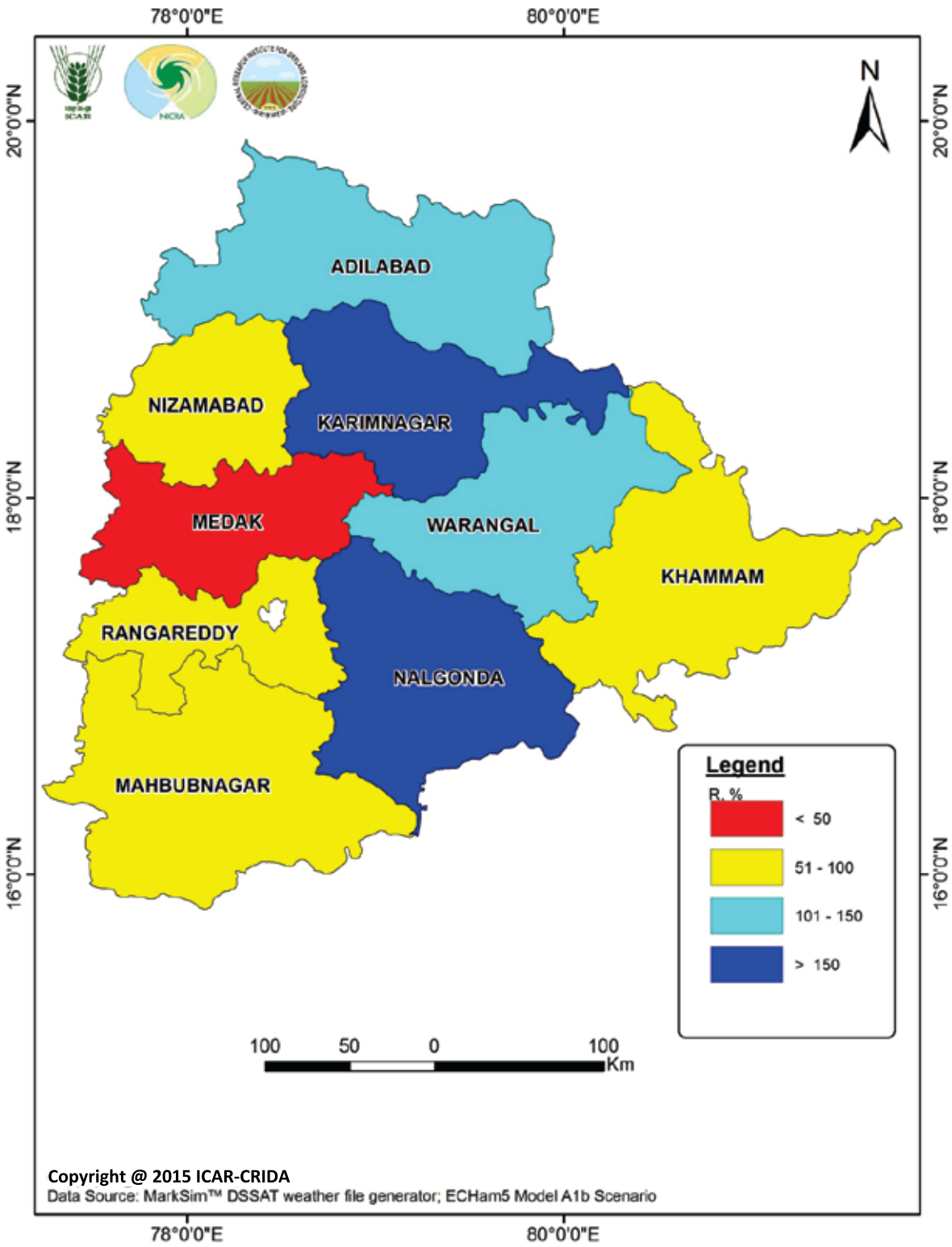

Fig.3.69 Percent decadal (2041-2050) deviation of rainfall (R) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

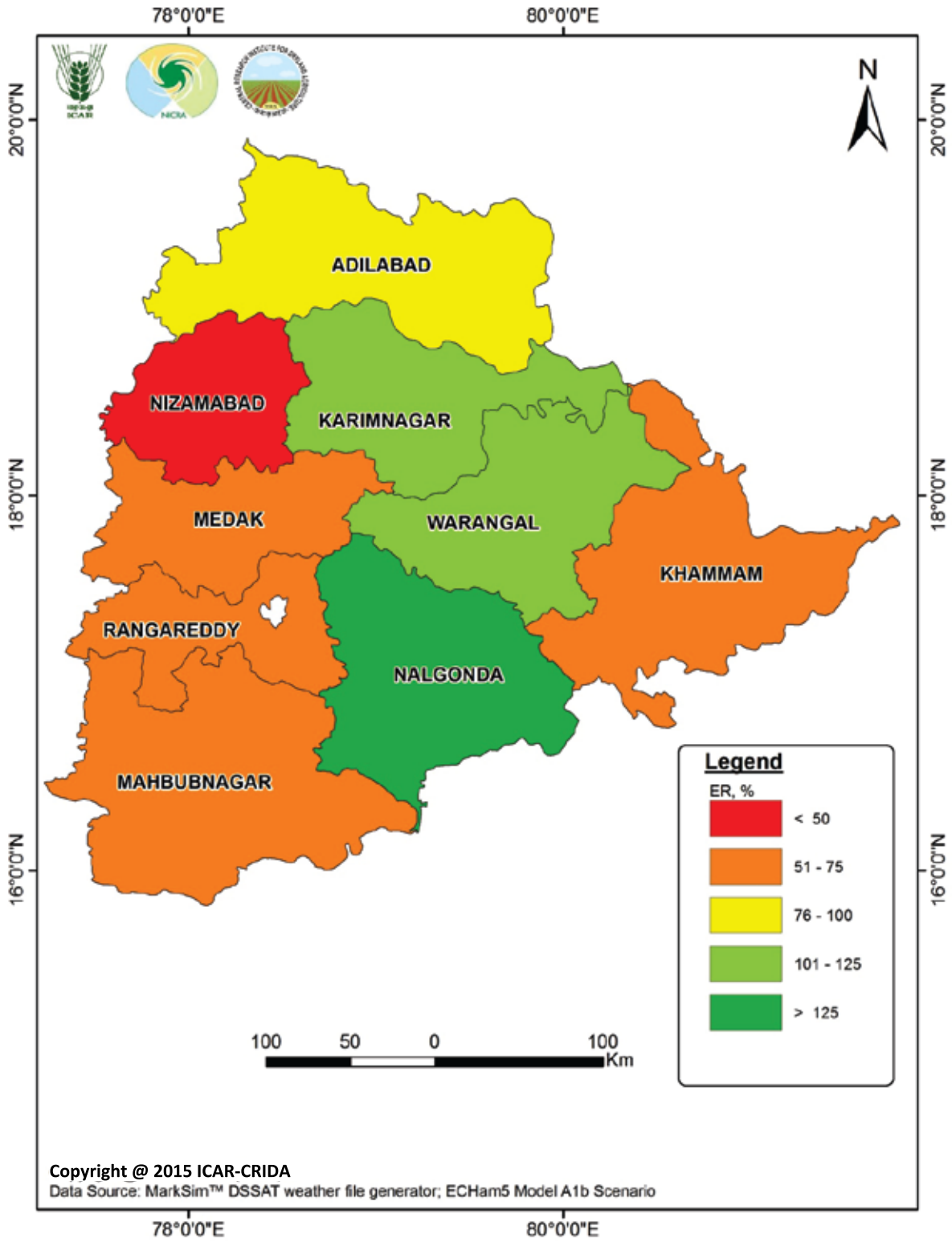

Fig.3.70 Percent decadal (2041-2050) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

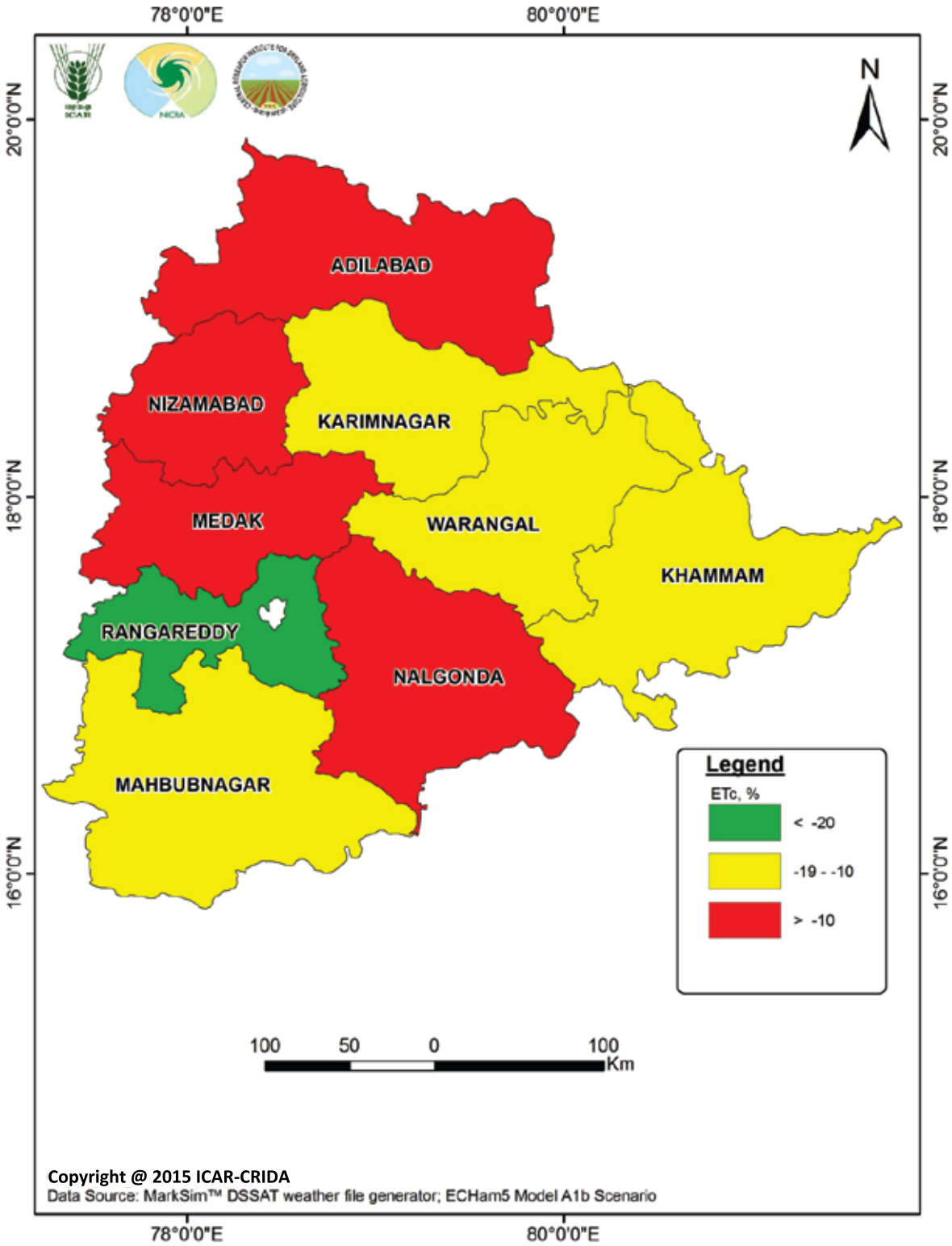

Fig.3.71 Percent decadal (2041-2050) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

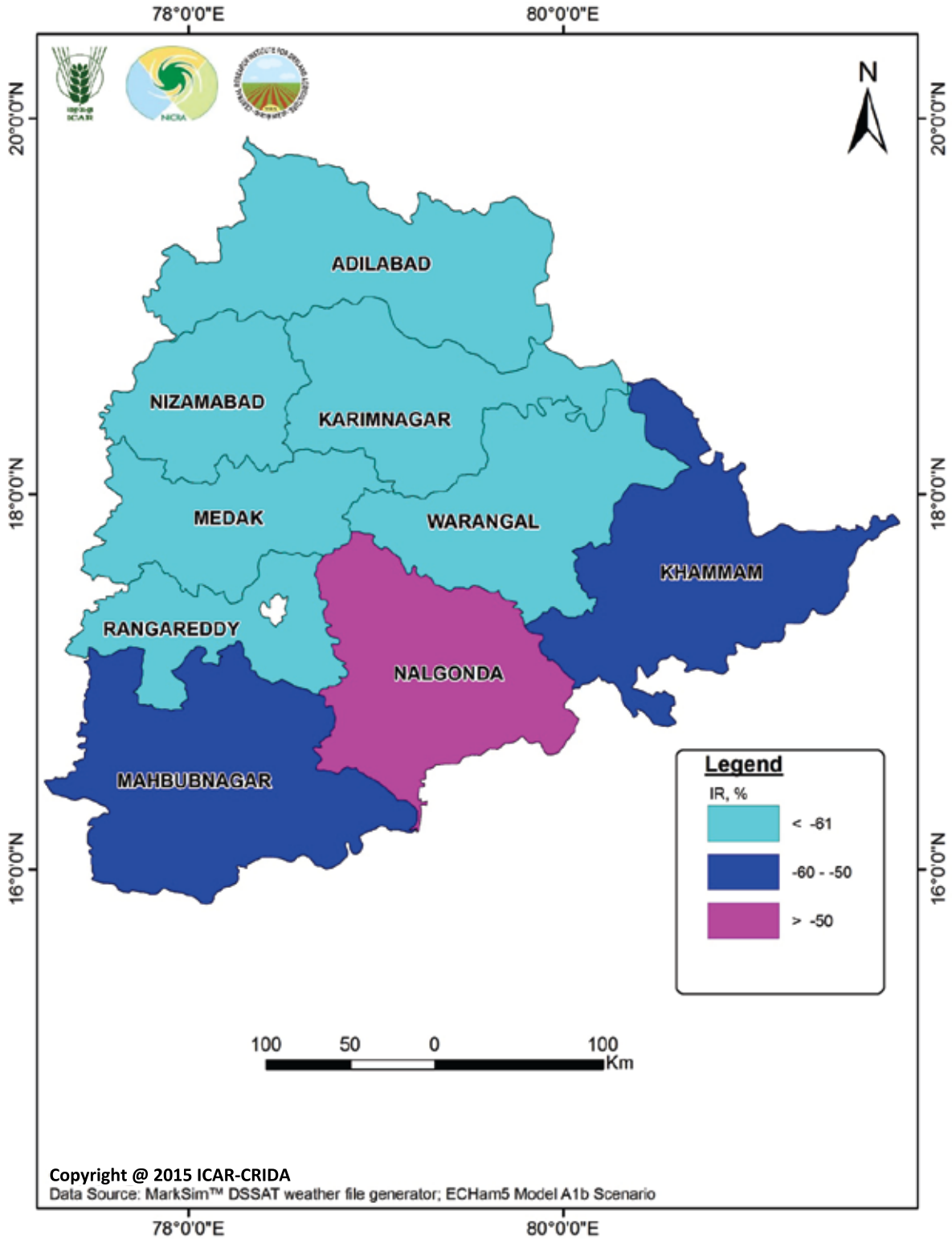

Fig.3.72 Percent decadal (2041-2050) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of cotton under late sowing in Telangana

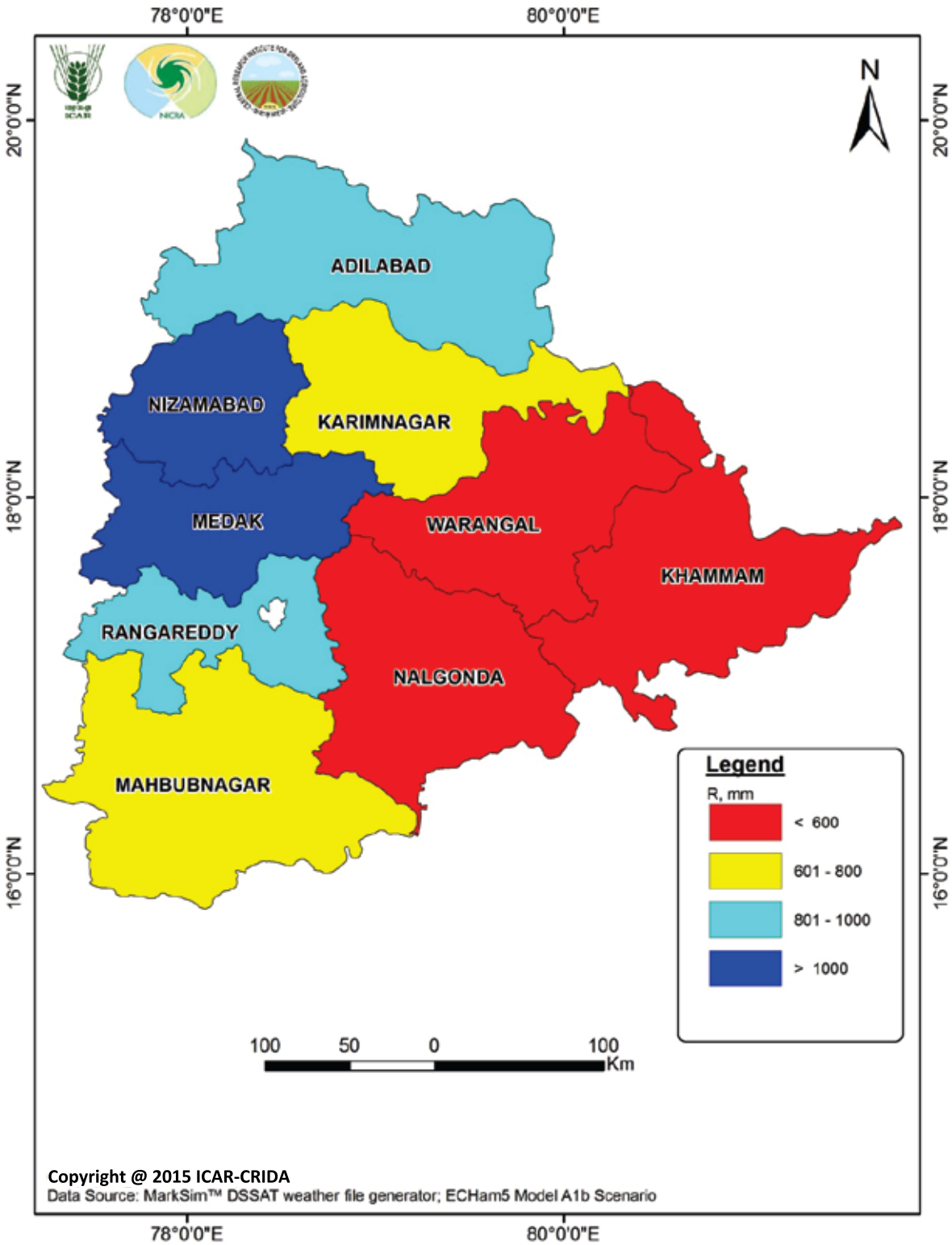

Fig.3.73 Rainfall (R) during crop growth period of maize under normal sowing for the base period (1961-1990) in Telangana

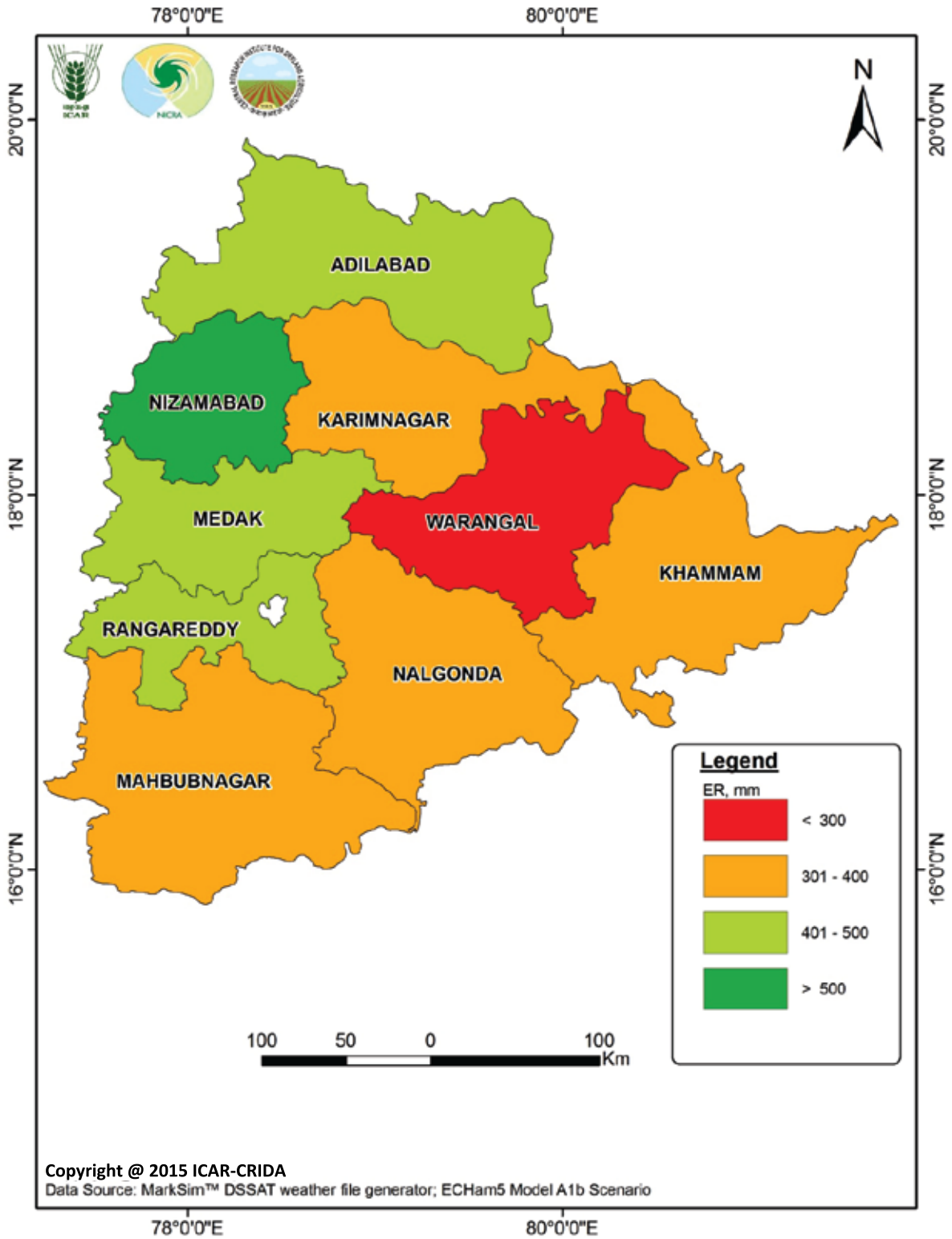

Fig.3.74 Effective rainfall (ER) during crop growth period of maize under normal sowing for the base period (1961-1990) in Telangana

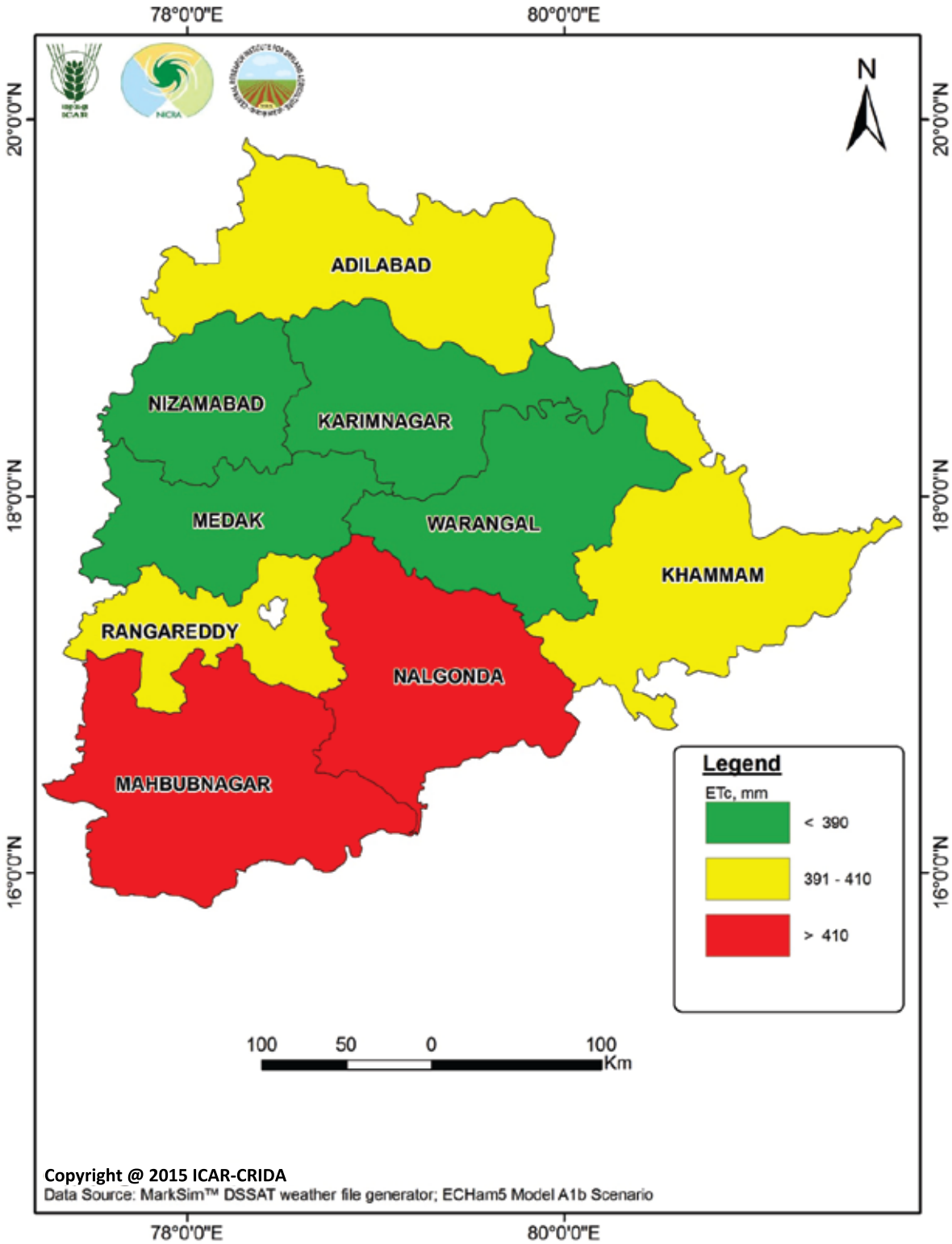

Fig.3.75 Crop evapotranspiration (ETc) during crop growth period of maize under normal sowing for the base period (1961-1990) in Telangana

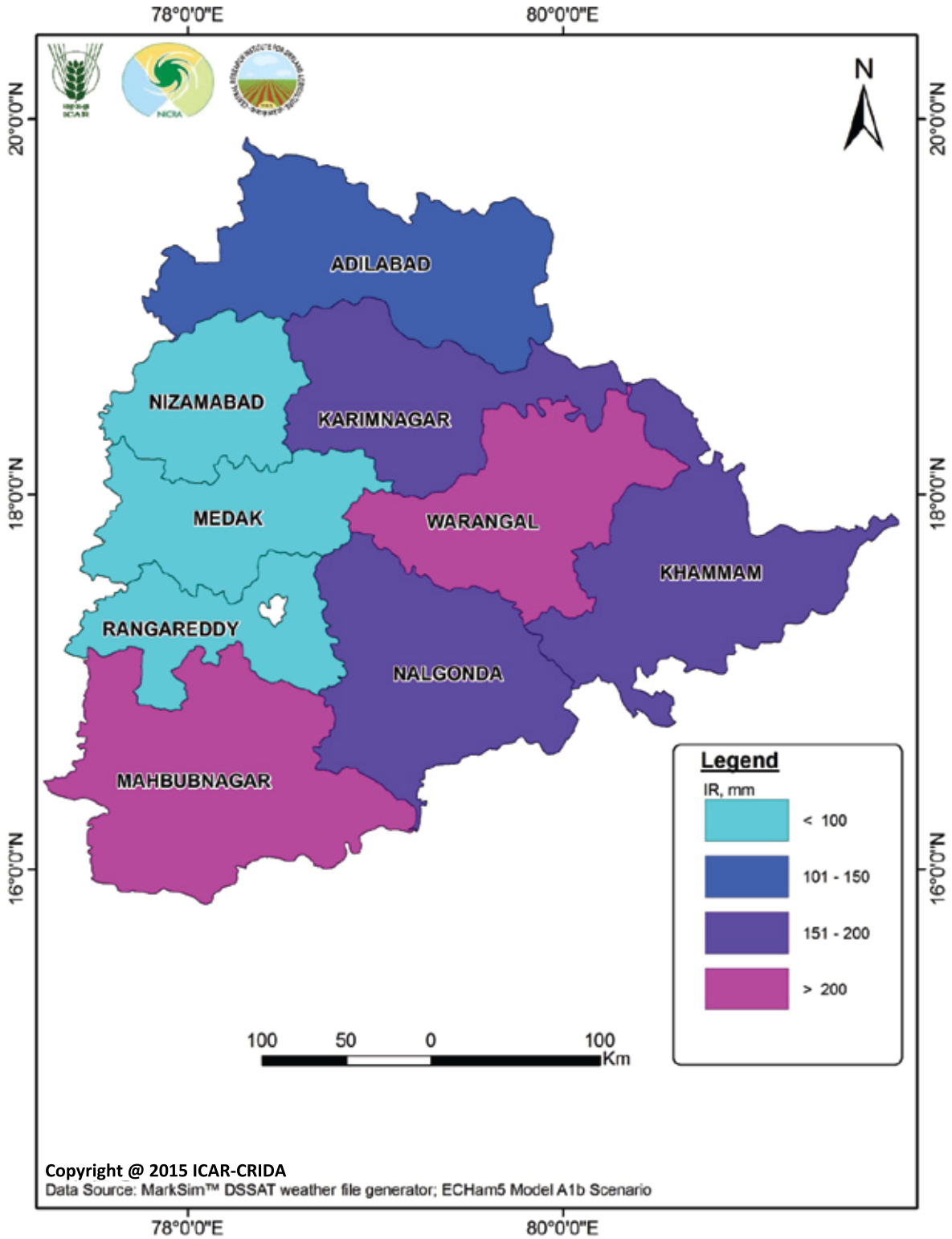

Fig.3.76 Irrigation requirement (IR) during crop growth period of maize under normal sowing for the base period (1961-1990) in Telangana

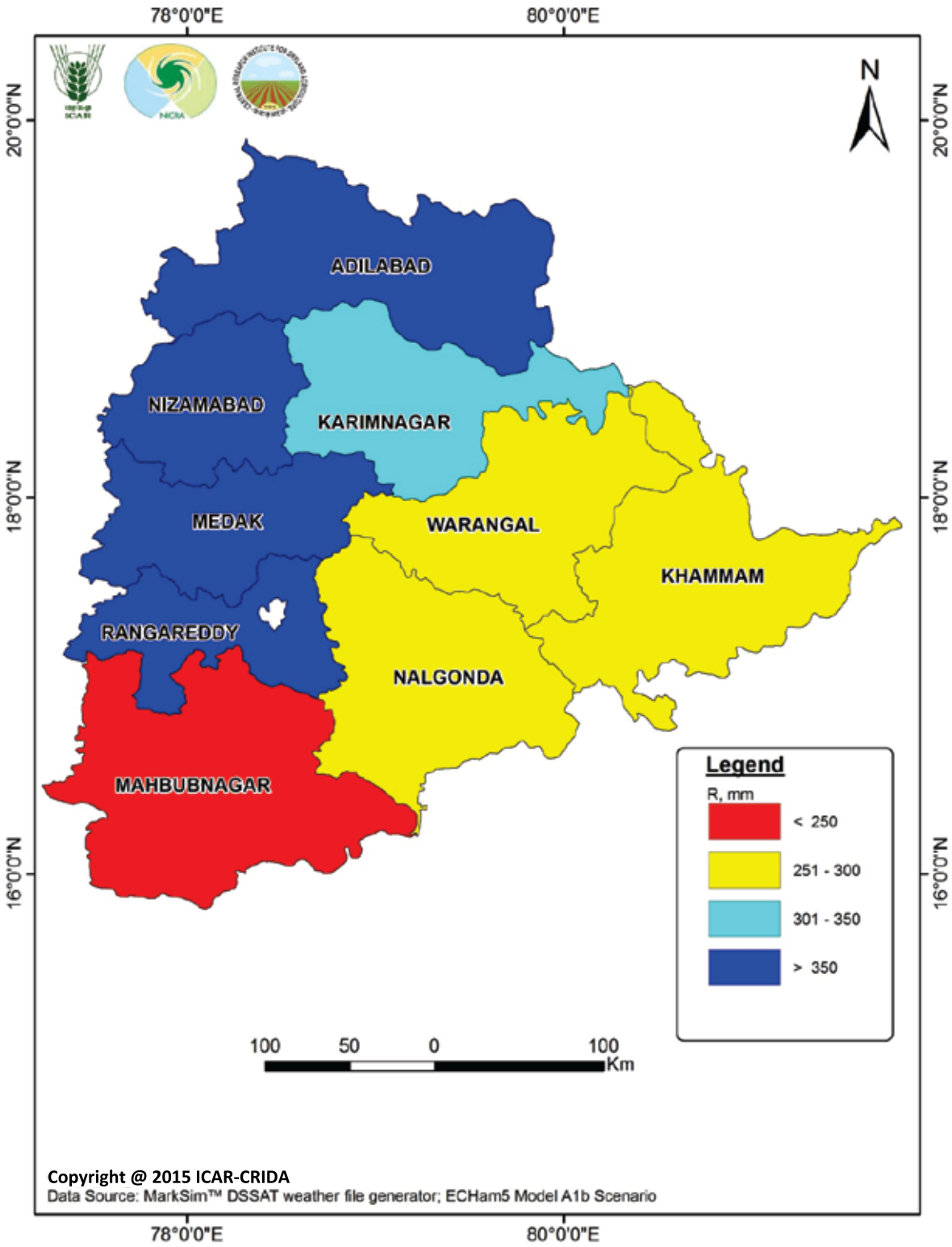

Fig.3.77 Rainfall (R) during crop growth period of maize under late sowing for the base period (1961-1990) in Telangana

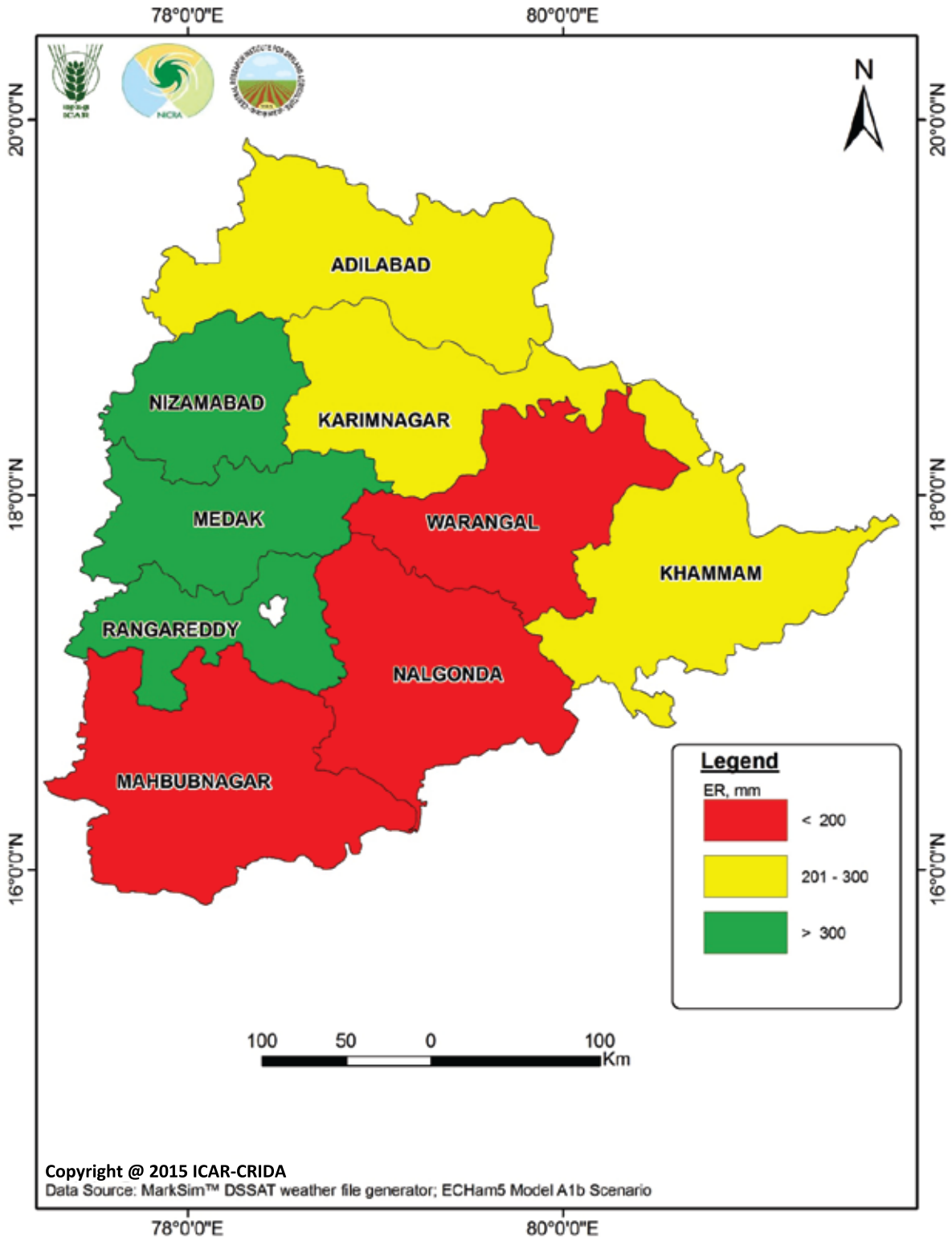

Fig.3.78 Effective rainfall (ER) during crop growth period of maize under late sowing for the base period (1961-1990) in Telangana

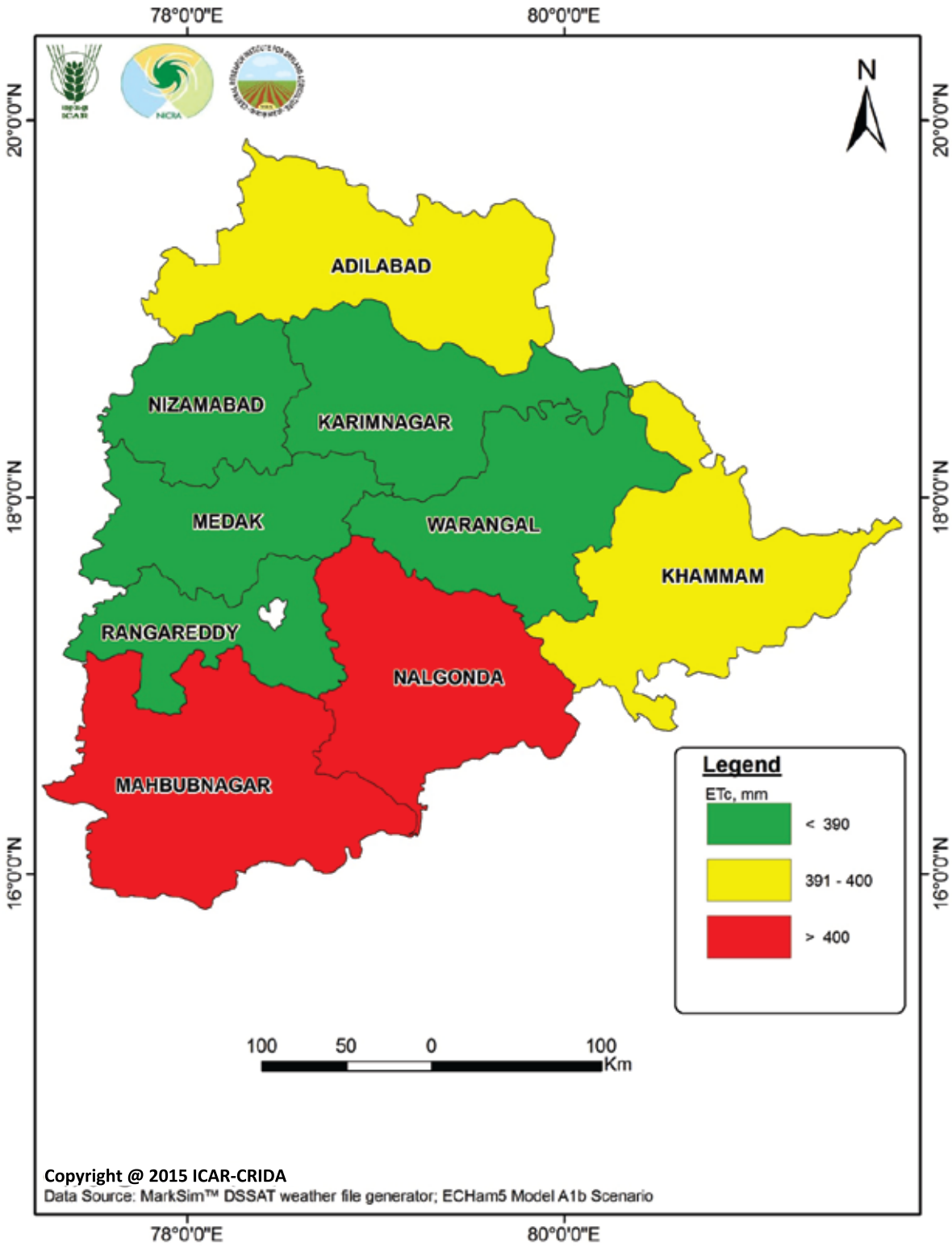

Fig.3.79 Crop evapotranspiration (ETc) during crop growth period of maize under late sowing for the base period (1961-1990) in Telangana

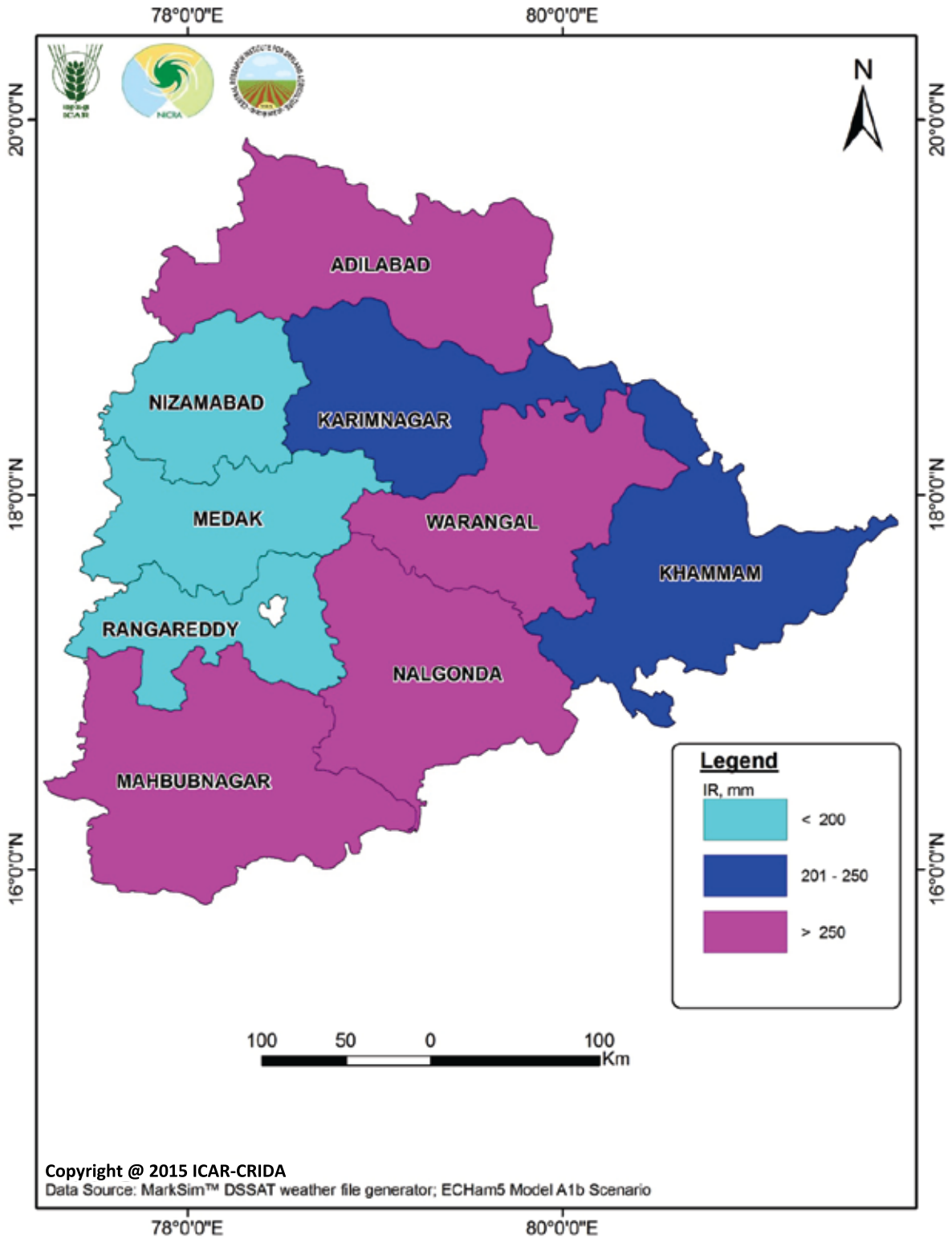

Fig.3.80 Irrigation requirement (IR) during crop growth period of maize under late sowing for the base period (1961-1990) in Telangana

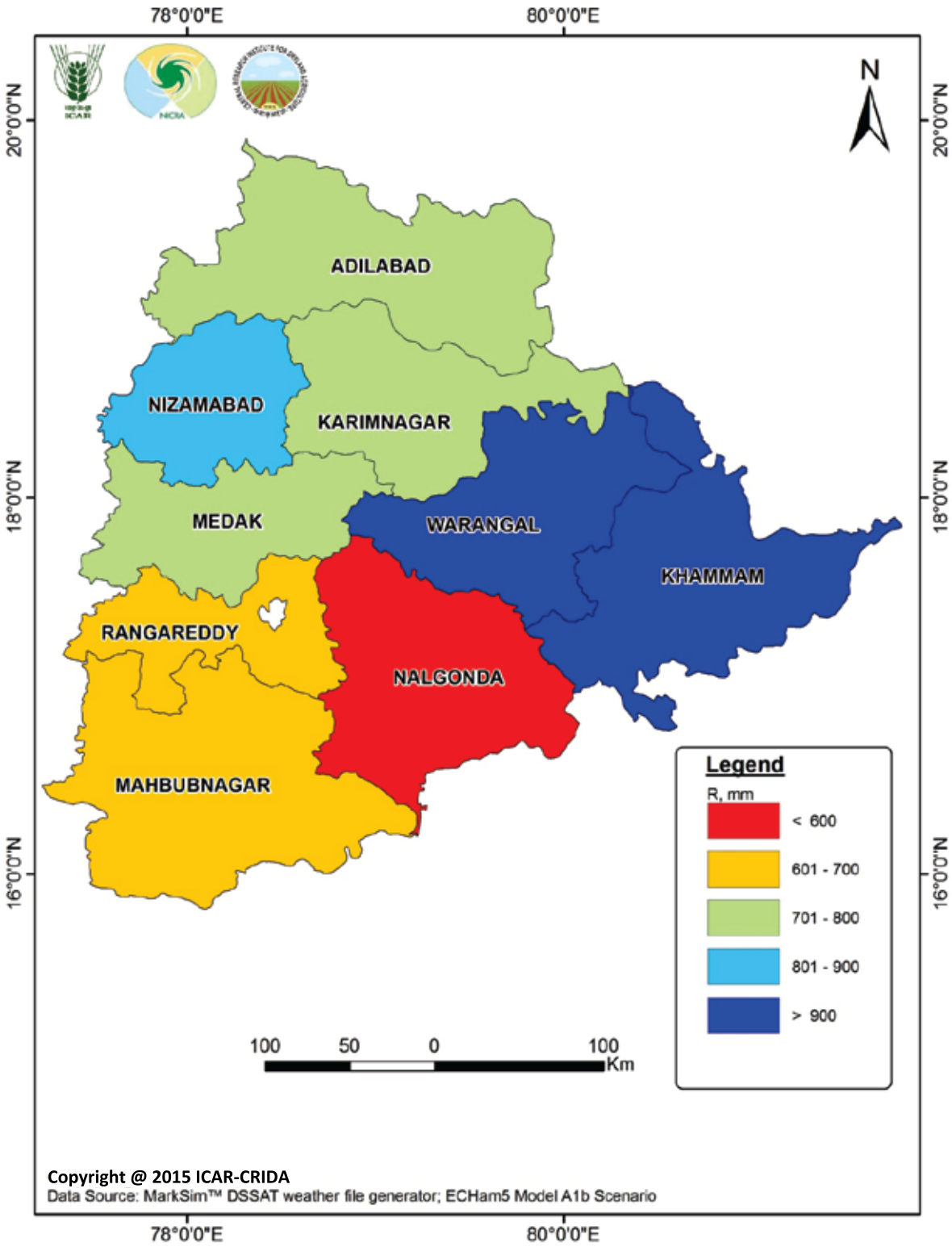

Fig.3.81 Rainfall (R) during crop growth period of maize under normal sowing for the decade 2011-2020 in Telangana

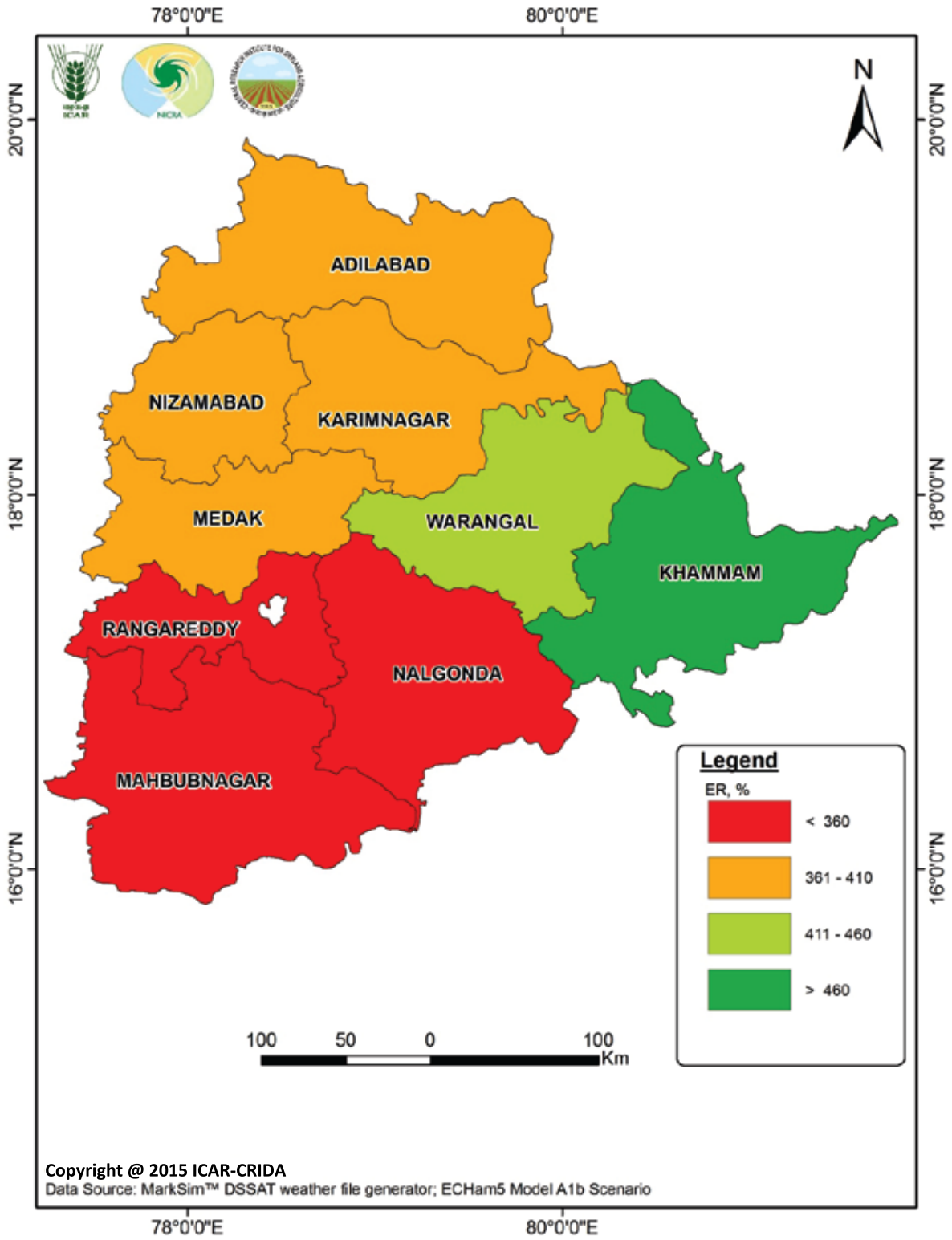

Fig.3.82 Effective rainfall (ER) during crop growth period of maize under normal sowing for the decade 2011-2020 in Telangana

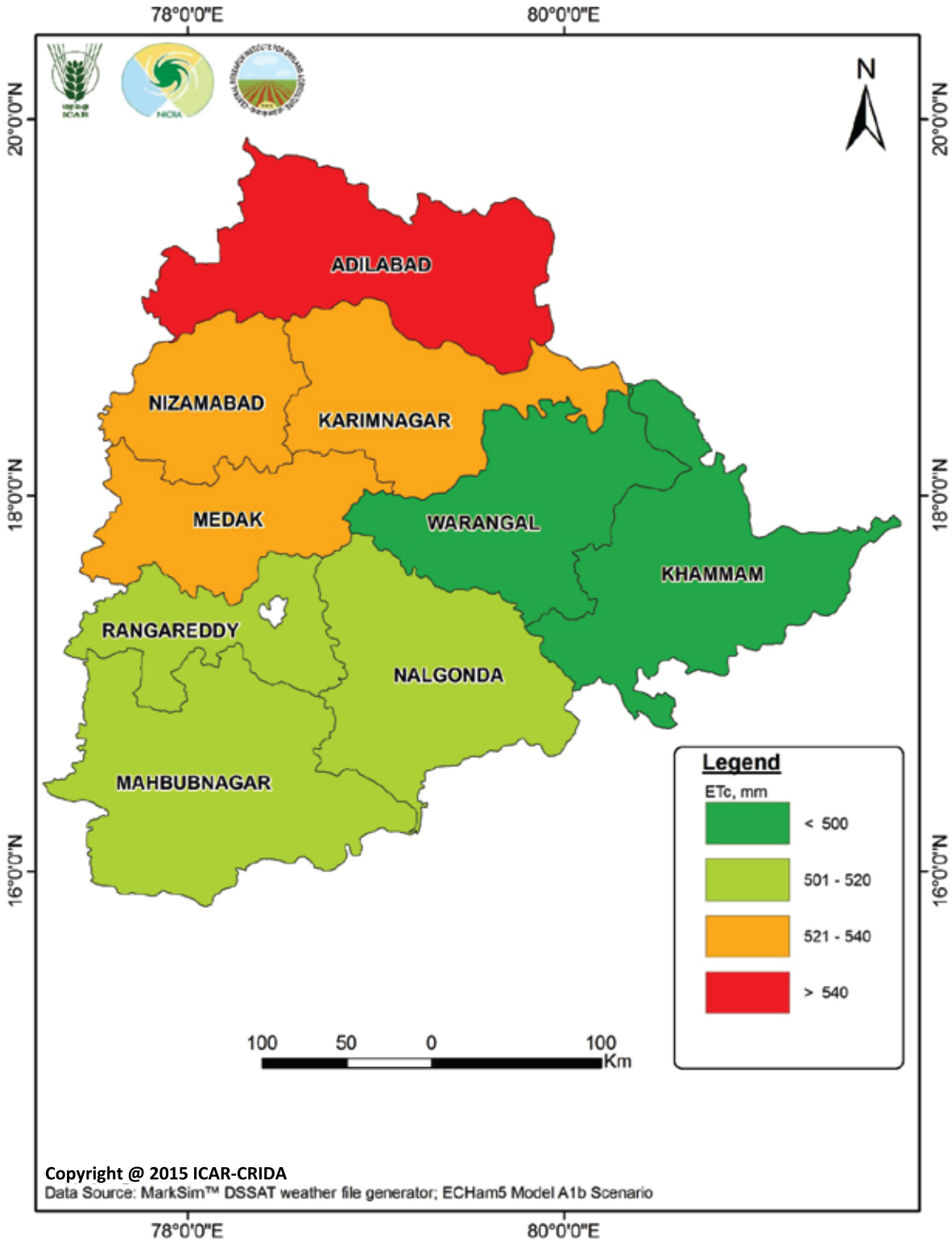

Fig.3.83 Crop evapotranspiration (ETc) during crop growth period of maize under normal sowing for the decade 2011-2020 in Telangana

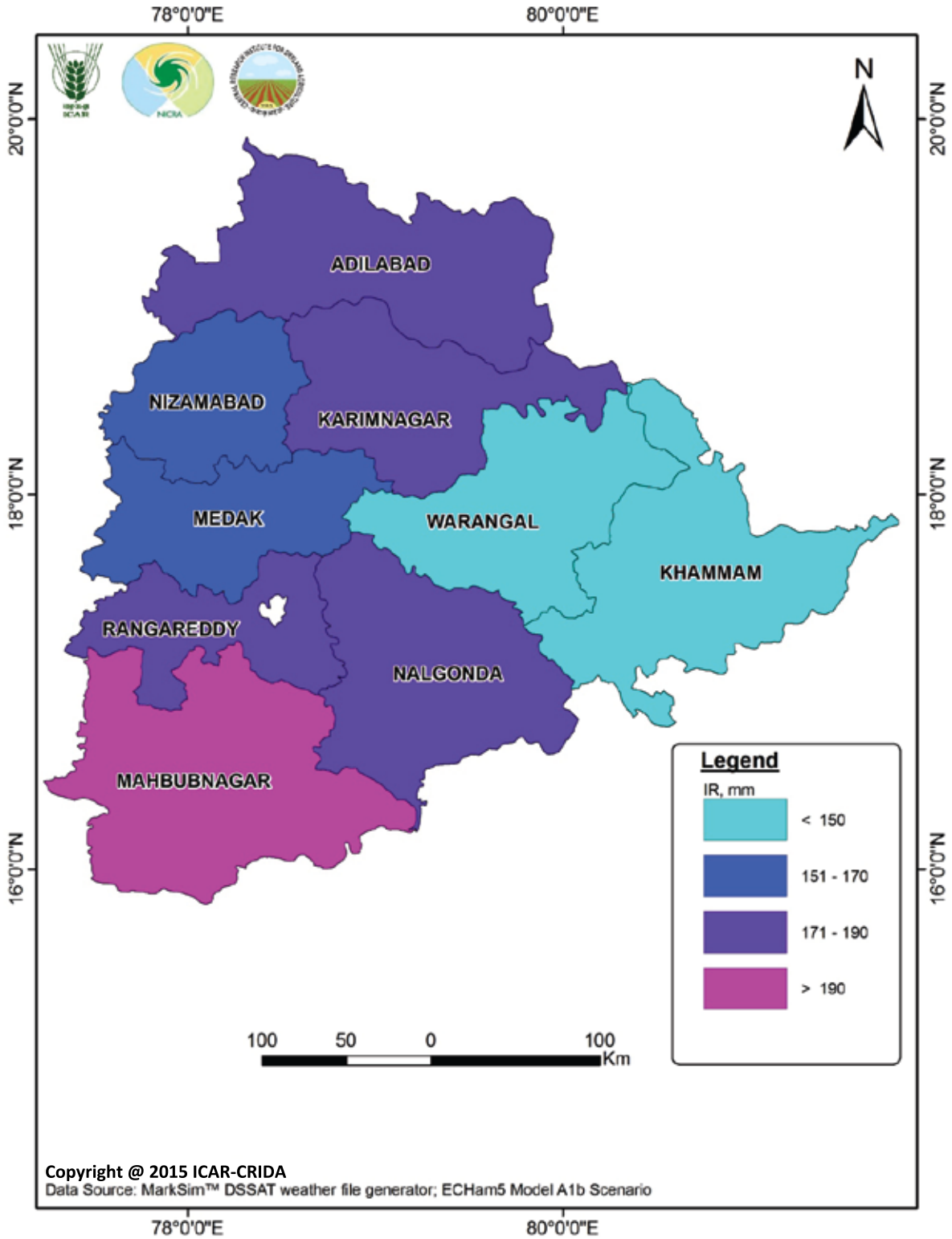

Fig.3.84 Irrigation requirement (IR) during crop growth period of maize under normal sowing for the decade 2011-2020 in Telangana

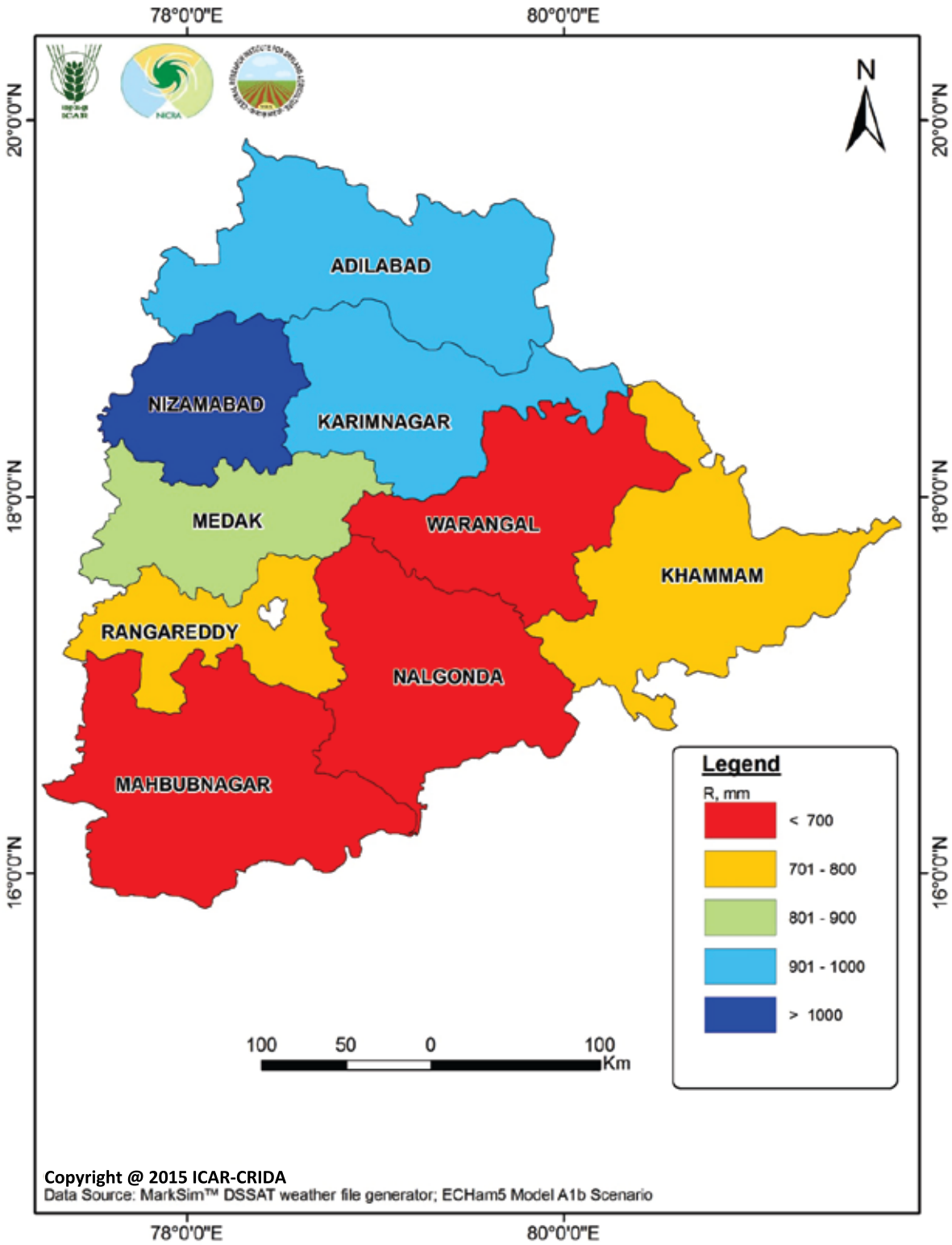

Fig.3.85 Rainfall (R) during crop growth period of maize under late sowing for the decade 2011-2020 in Telangana

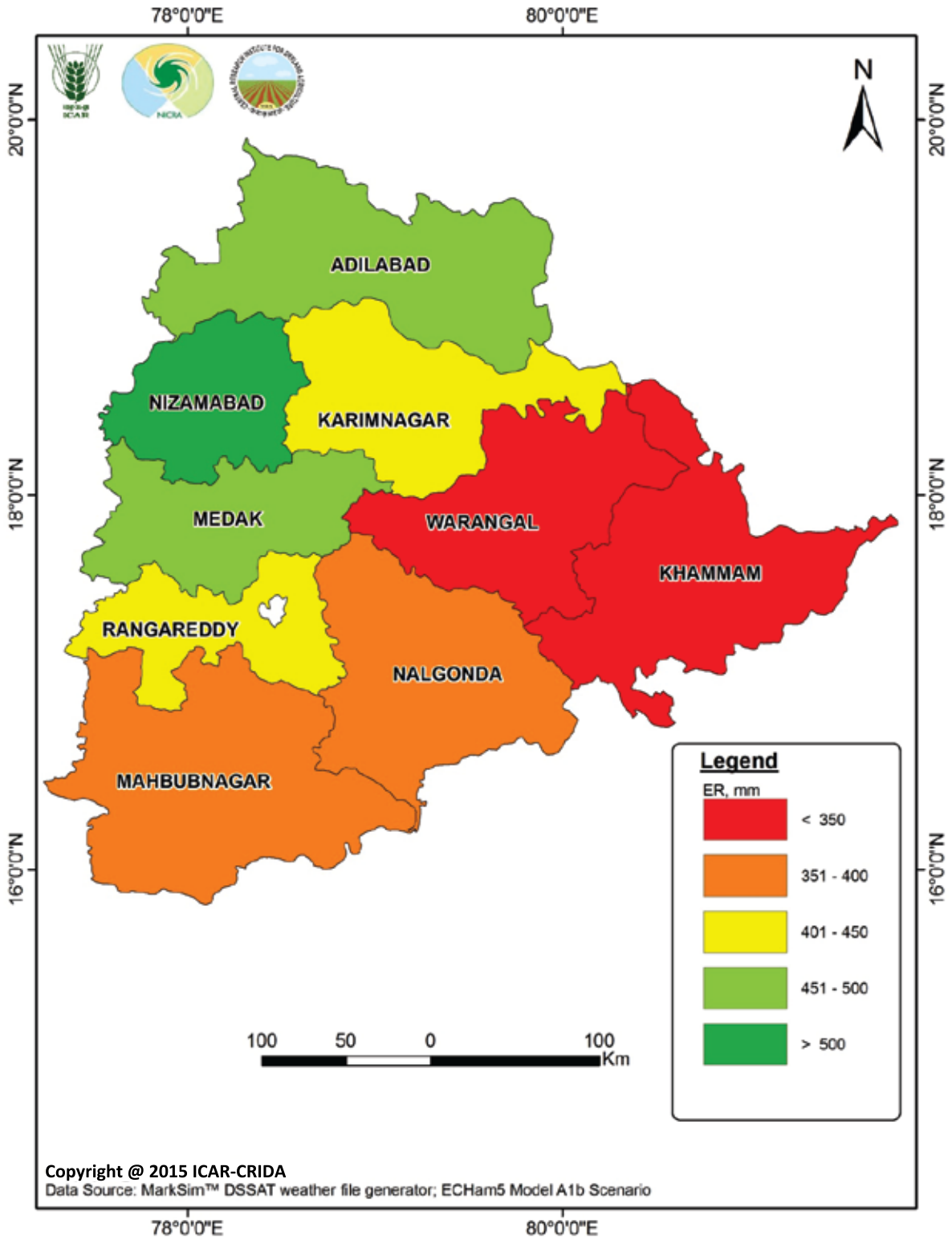

Fig.3.86 Effective rainfall (ER) during crop growth period of maize under late sowing for the decade 2011-2020 in Telangana

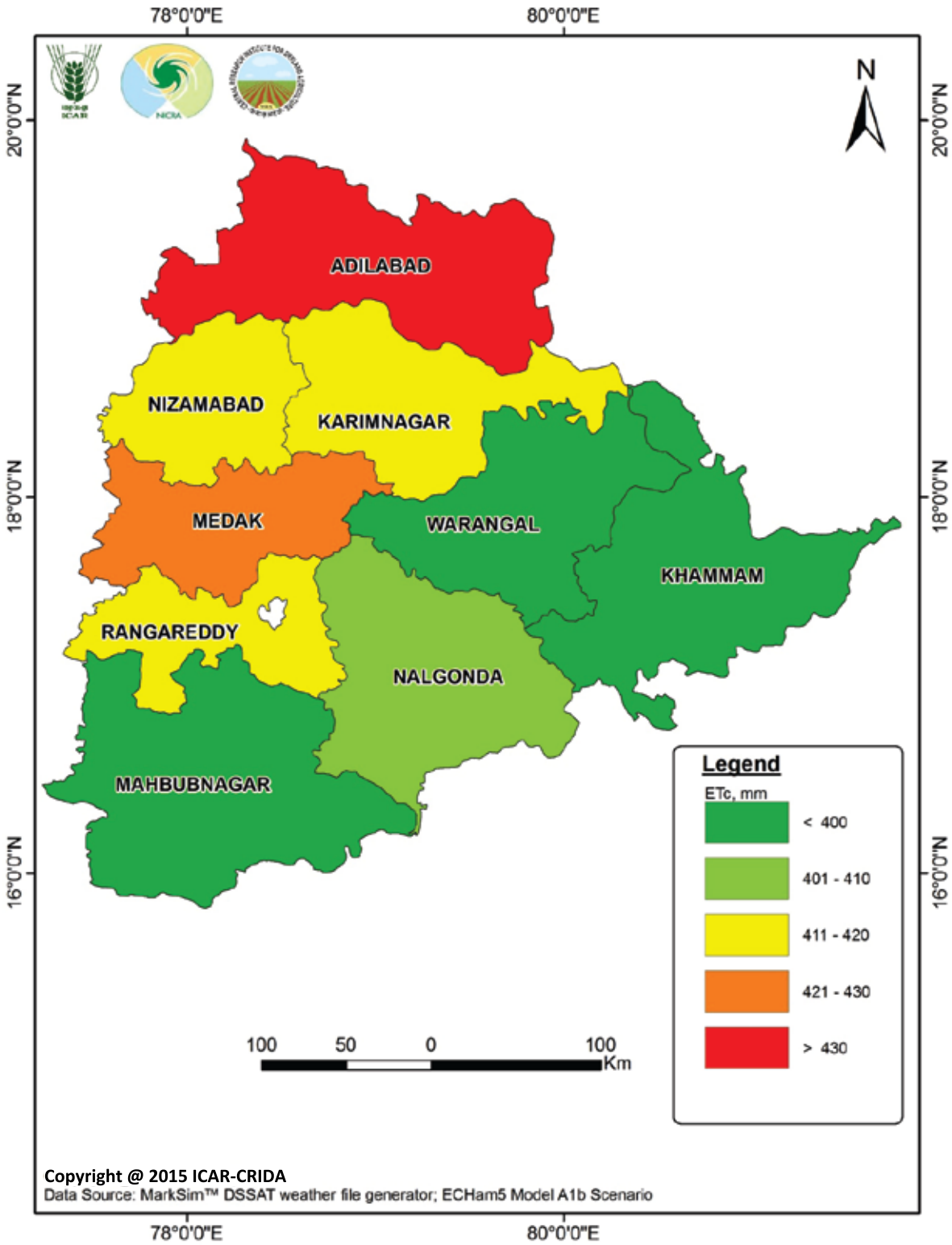

Fig.3.87 Crop evapotranspiration (ETc) during crop growth period of maize under late sowing for the decade 2011-2020 in Telangana

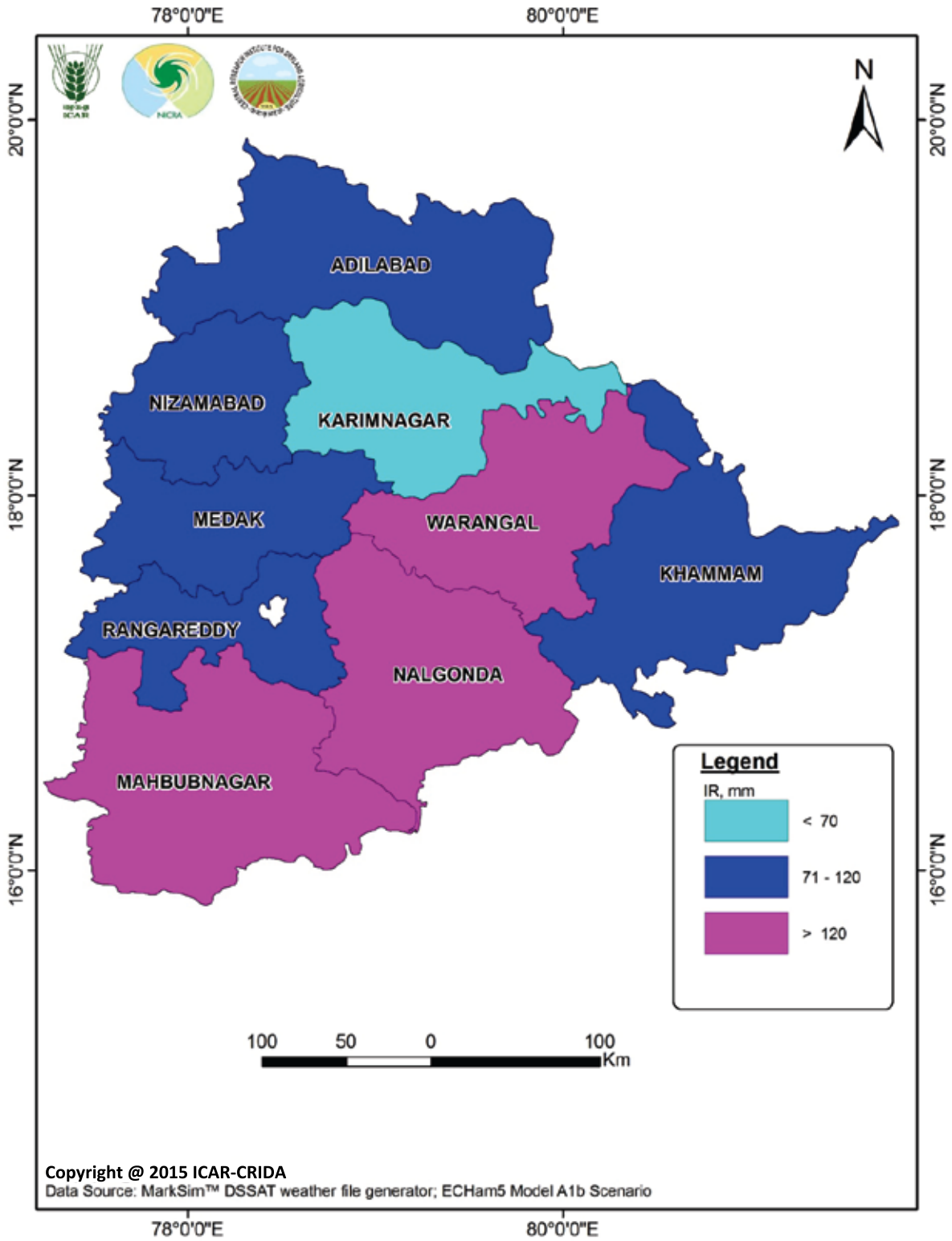

Fig.3.88 Irrigation requirement (IR) during crop growth period of maize under late sowing for the decade 2011-2020 in Telangana

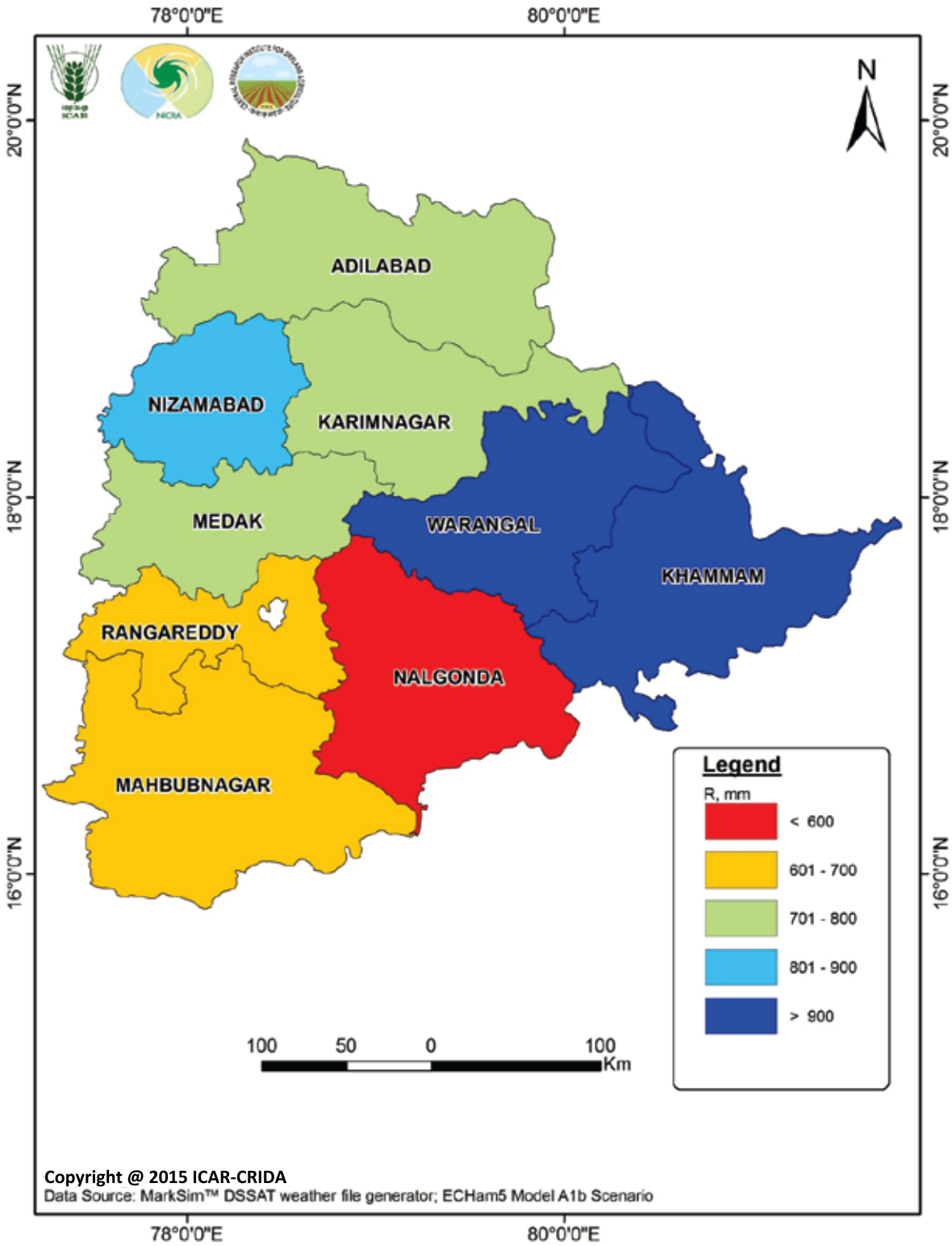

Fig.3.89 Rainfall (R) during crop growth period of maize under normal sowing for the decade 2021-2030 in Telangana

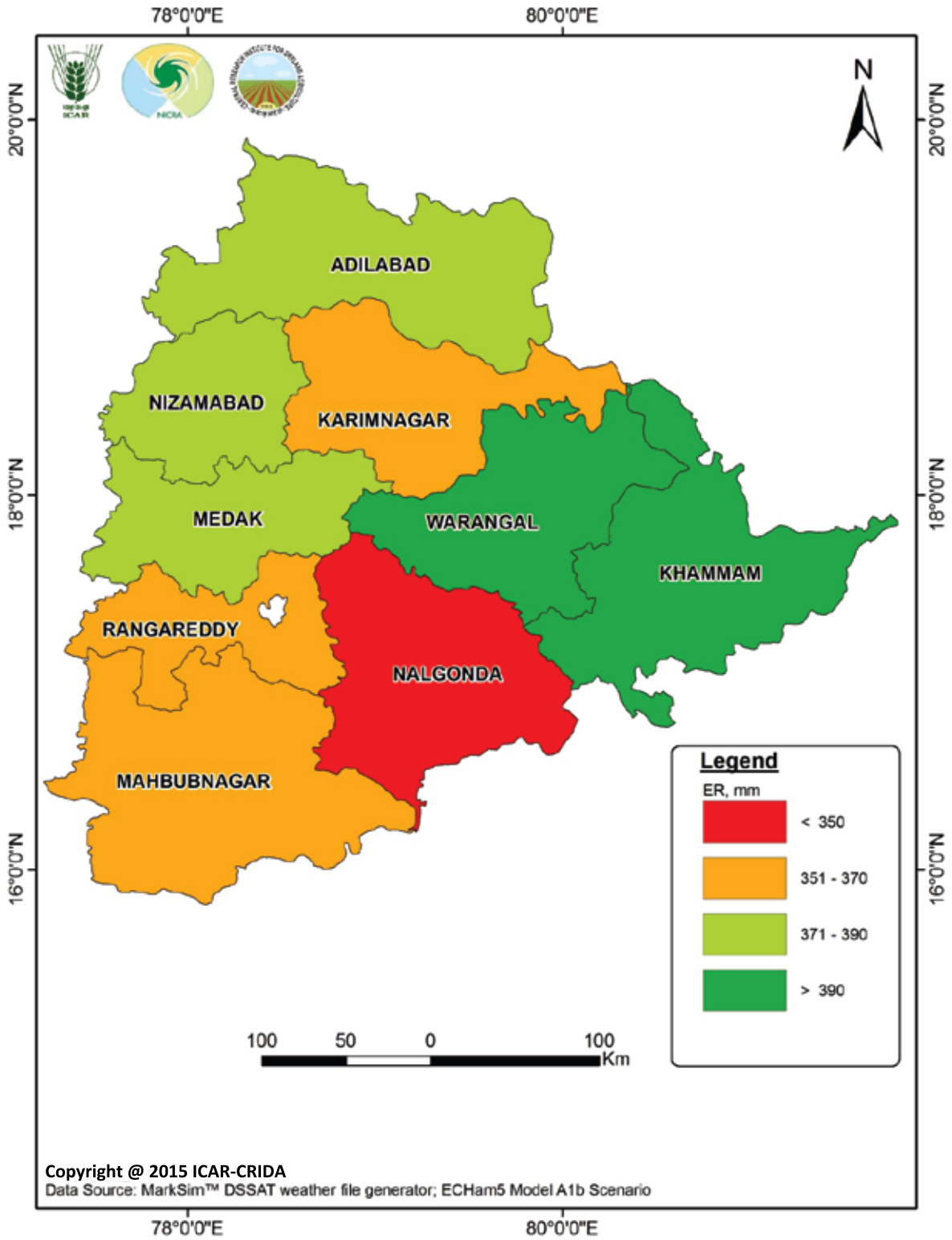

Fig.3.90 Effective rainfall (ER) during crop growth period of maize under normal sowing for the decade 2021-2030 in Telangana

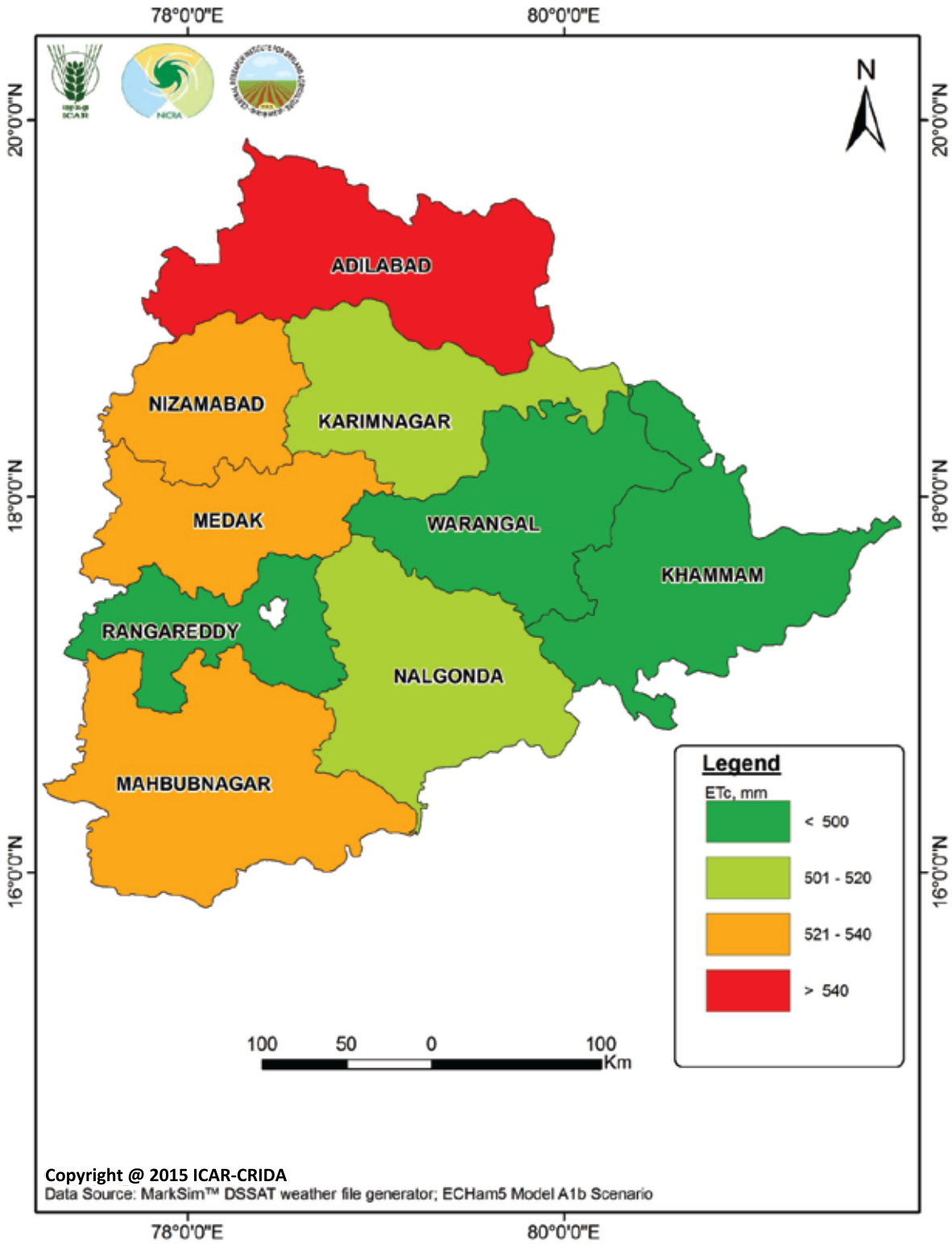

Fig.3.91 Crop evapotranspiration (ETc) during crop growth period of maize under normal sowing for the decade 2021-2030 in Telangana

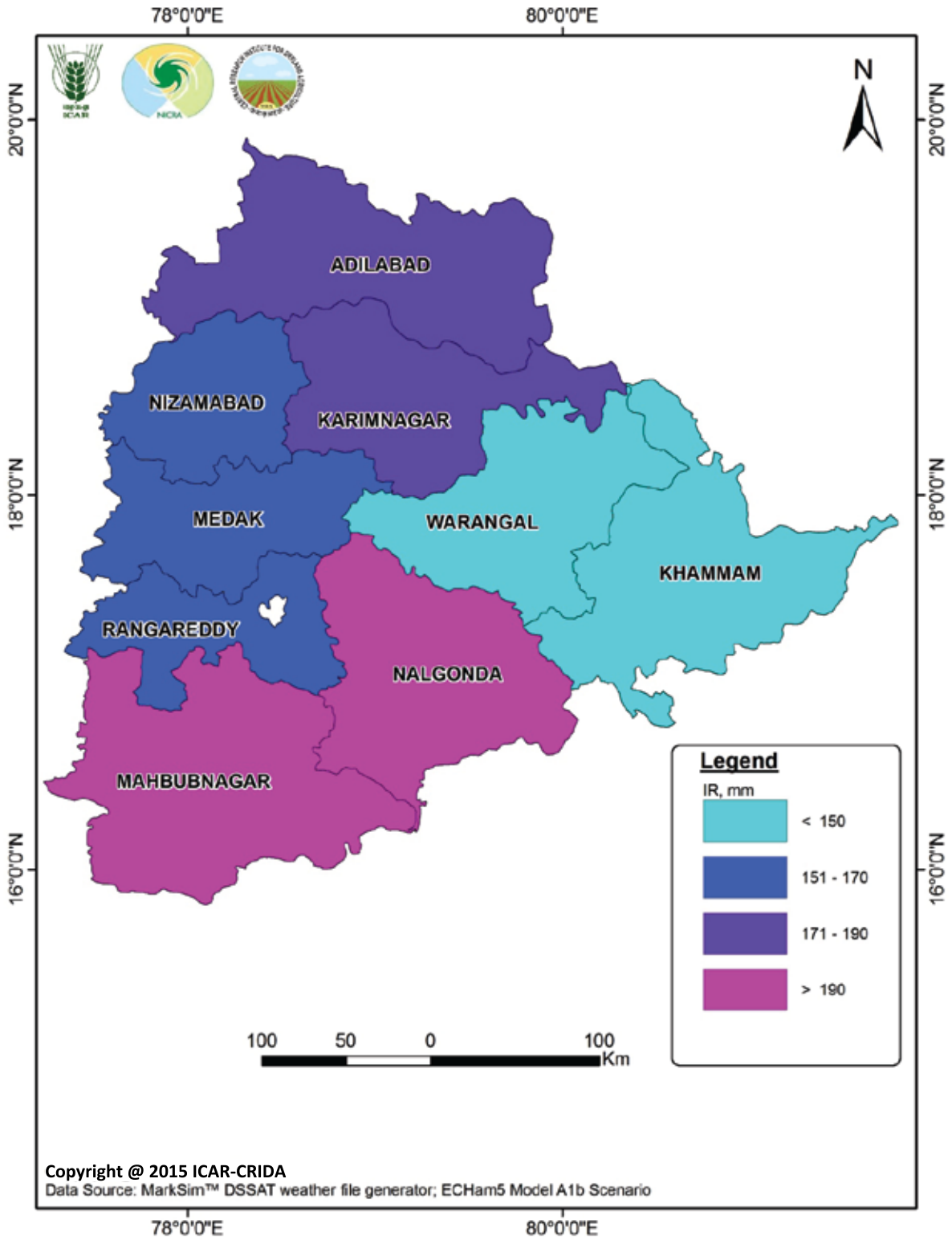

Fig.3.92 Irrigation requirement (IR) during crop growth period of maize under normal sowing for the decade 2021-2030 in Telangana

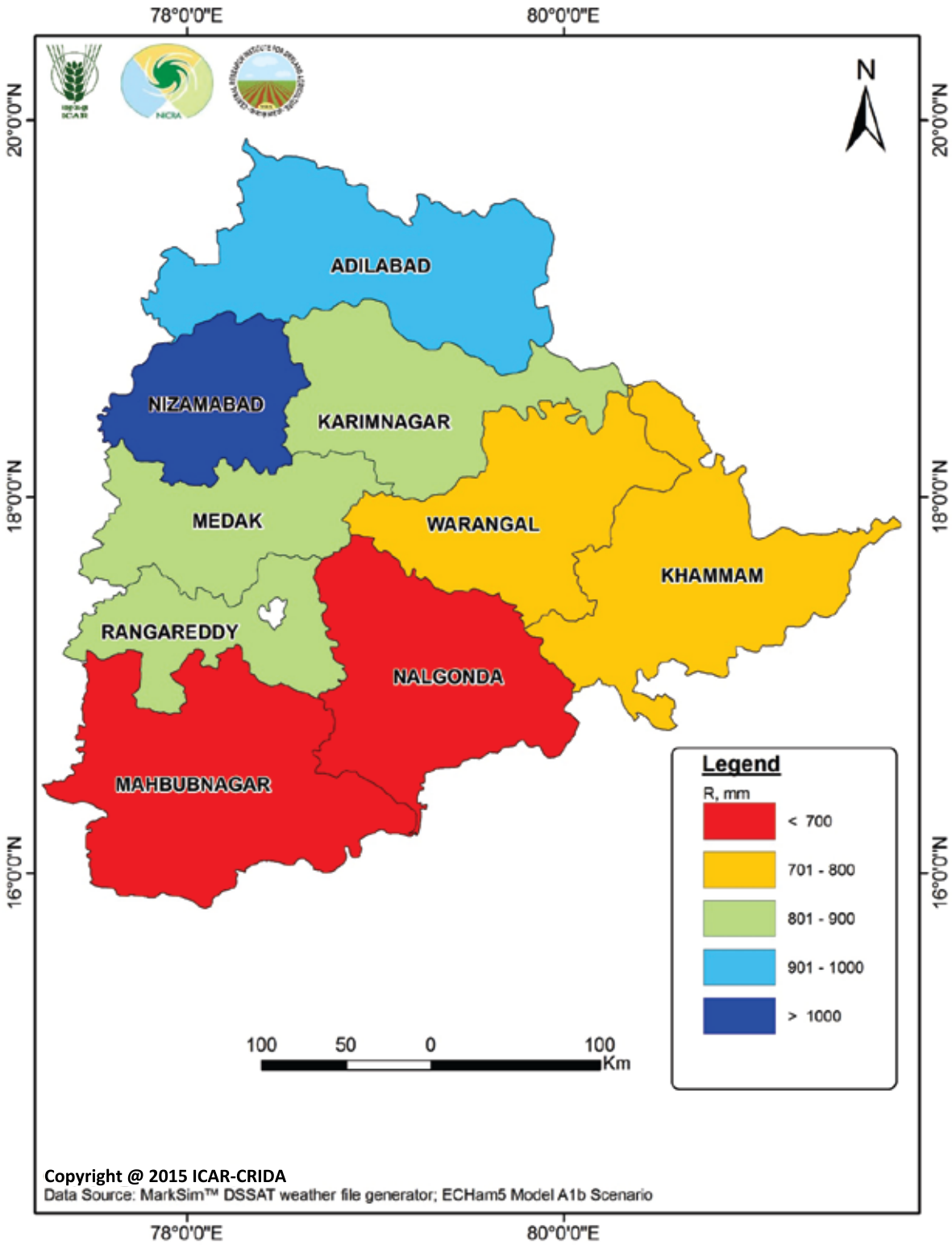

Fig.3.93 Rainfall (R) during crop growth period of maize under late sowing for the decade 2021-2030 in Telangana

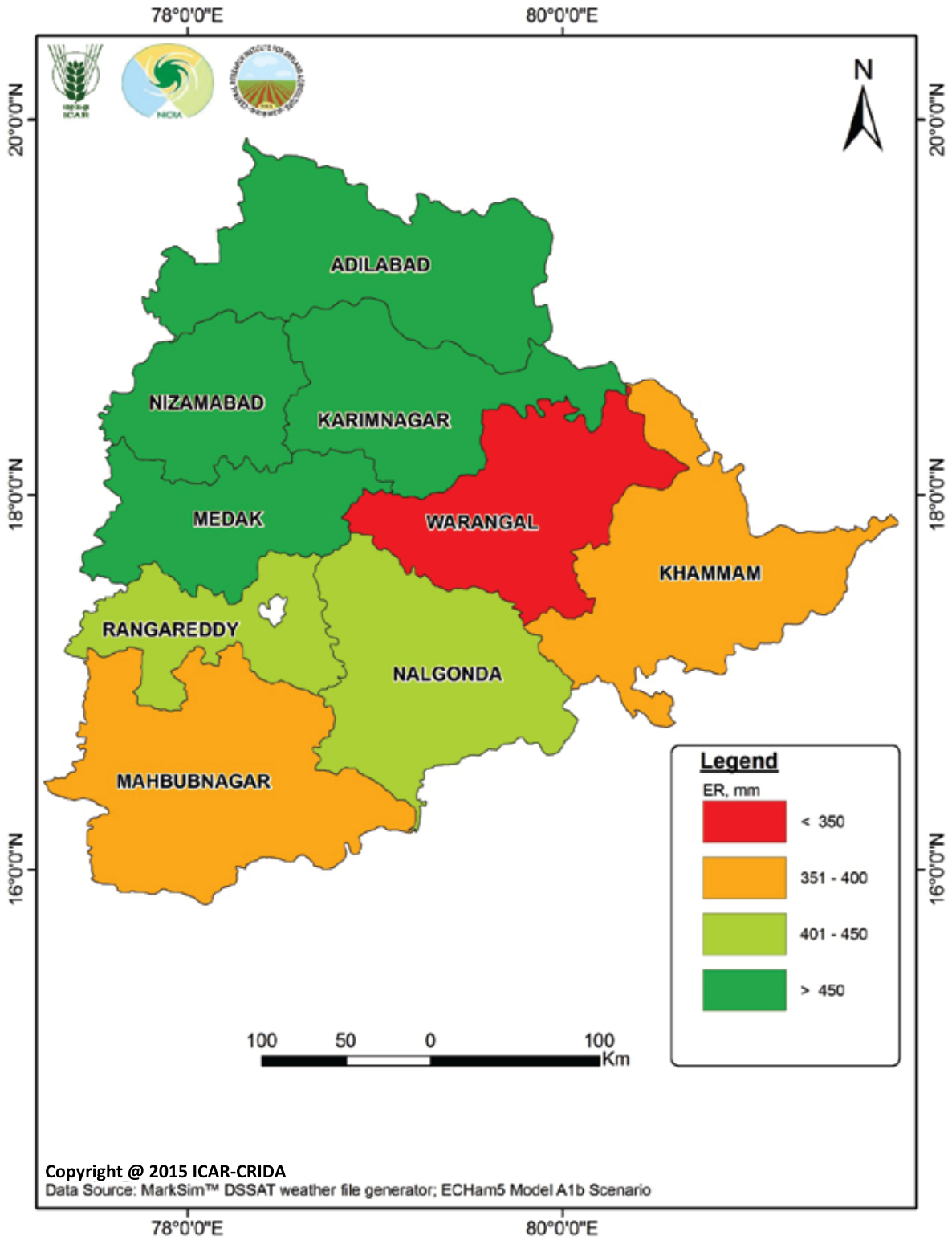

Fig.3.94 Effective rainfall (ER) during crop growth period of maize under late sowing for the decade 2021-2030 in Telangana

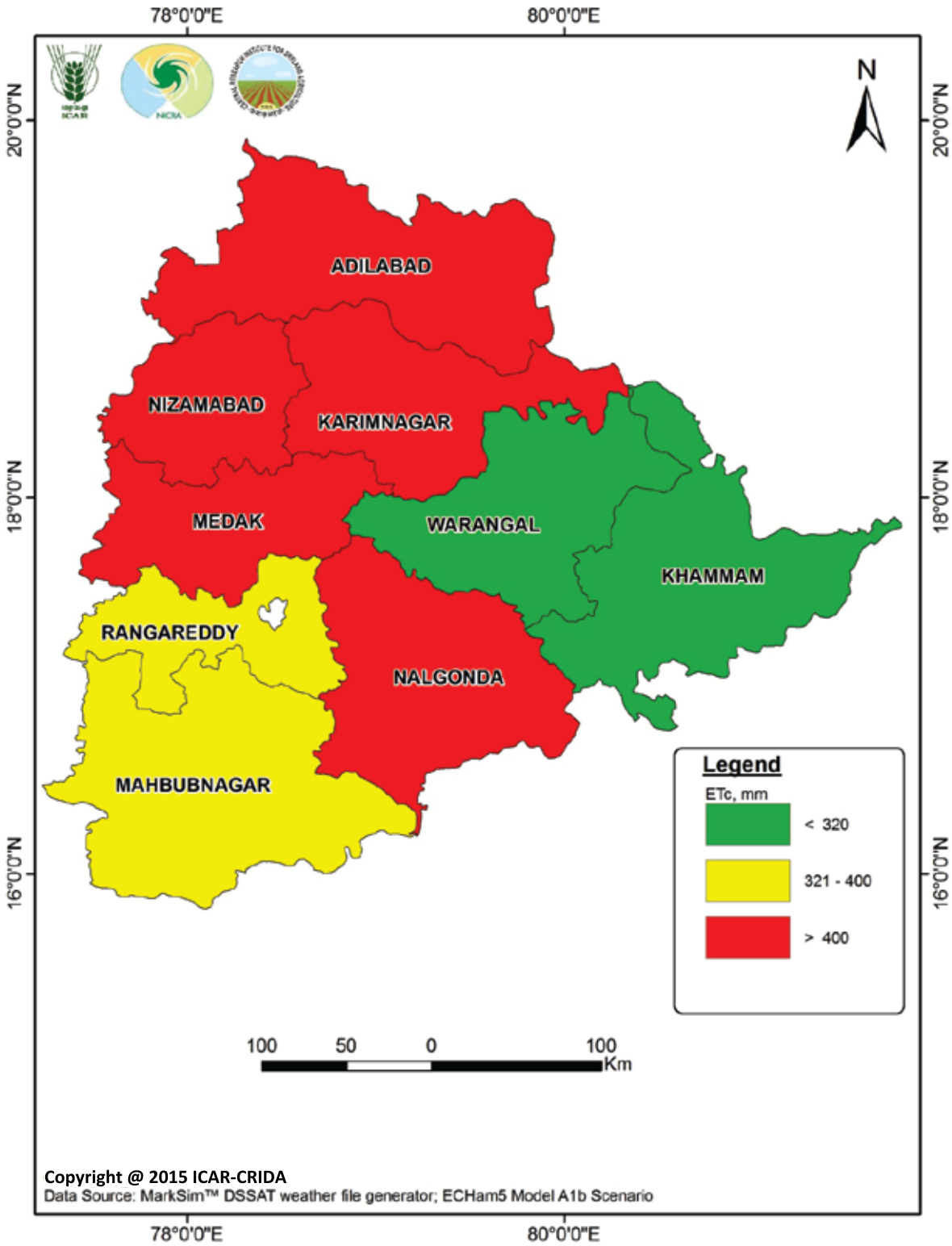

Fig.3.95 Crop evapotranspiration (ETc) during crop growth period of maize under late sowing for the decade 2021-2030 in Telangana

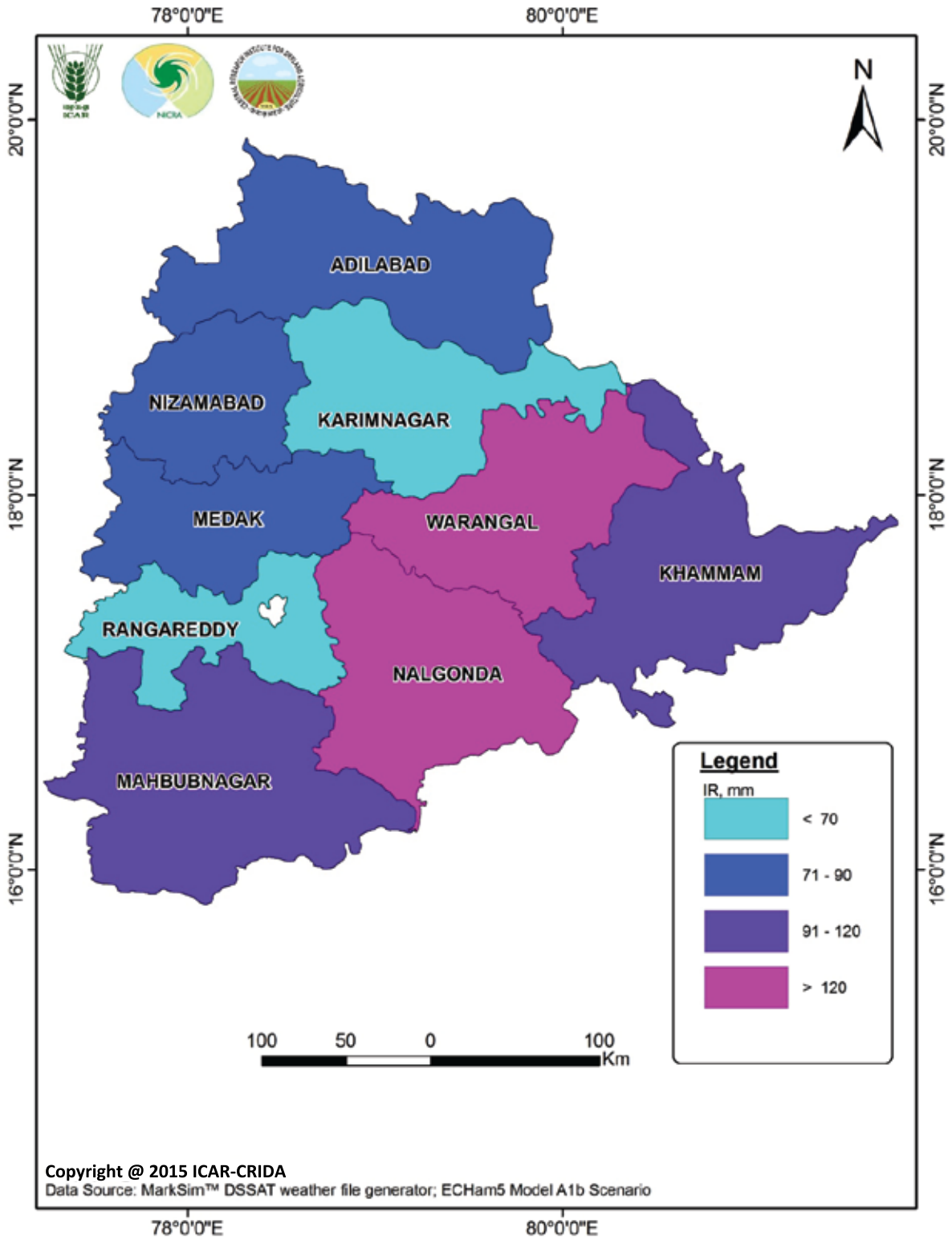

Fig.3.96 Irrigation requirement (IR) during crop growth period of maize under late sowing for the decade 2021-2030 in Telangana

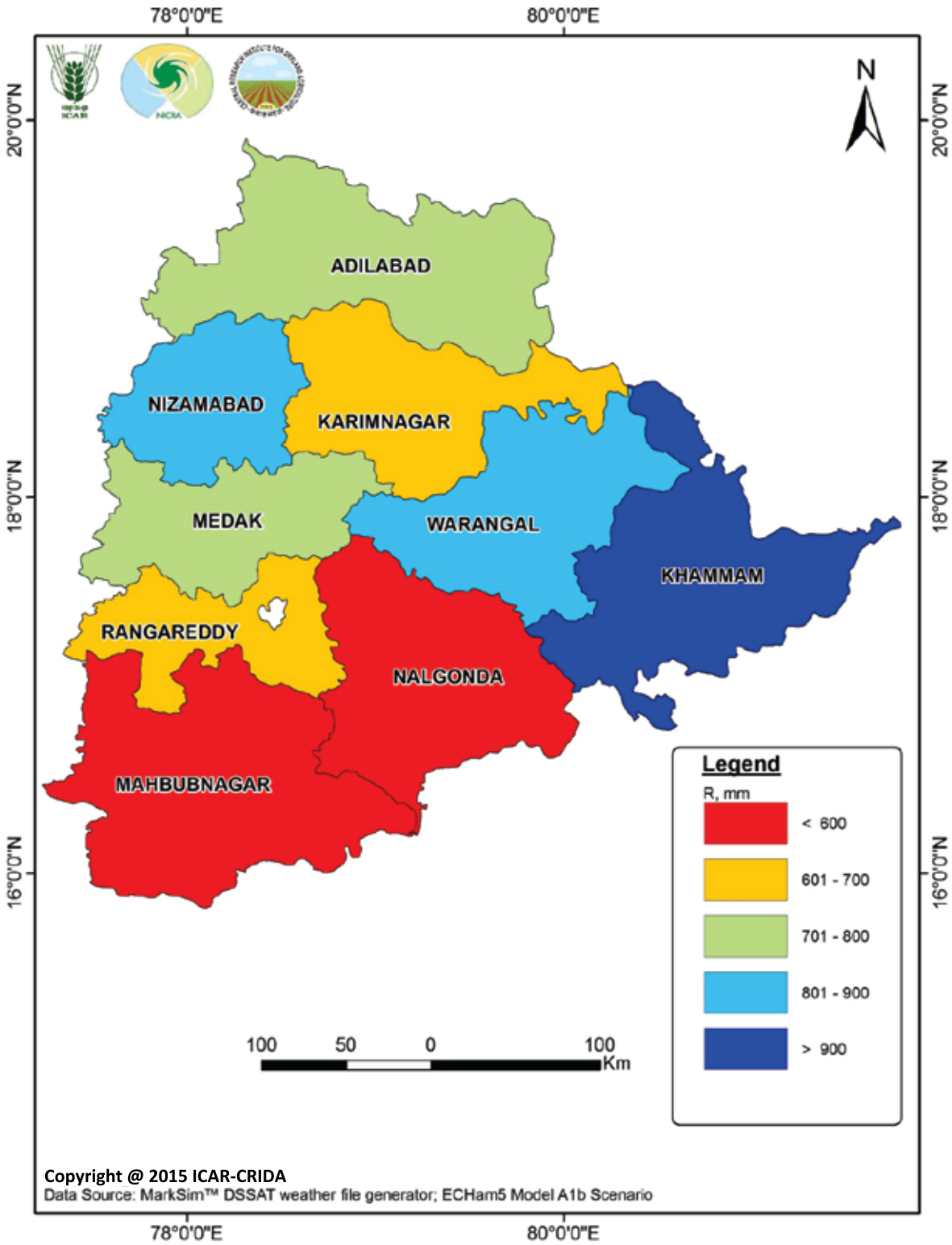

Fig.3.97 Rainfall (R) during crop growth period of maize under normal sowing for the decade 2031-2040 in Telangana

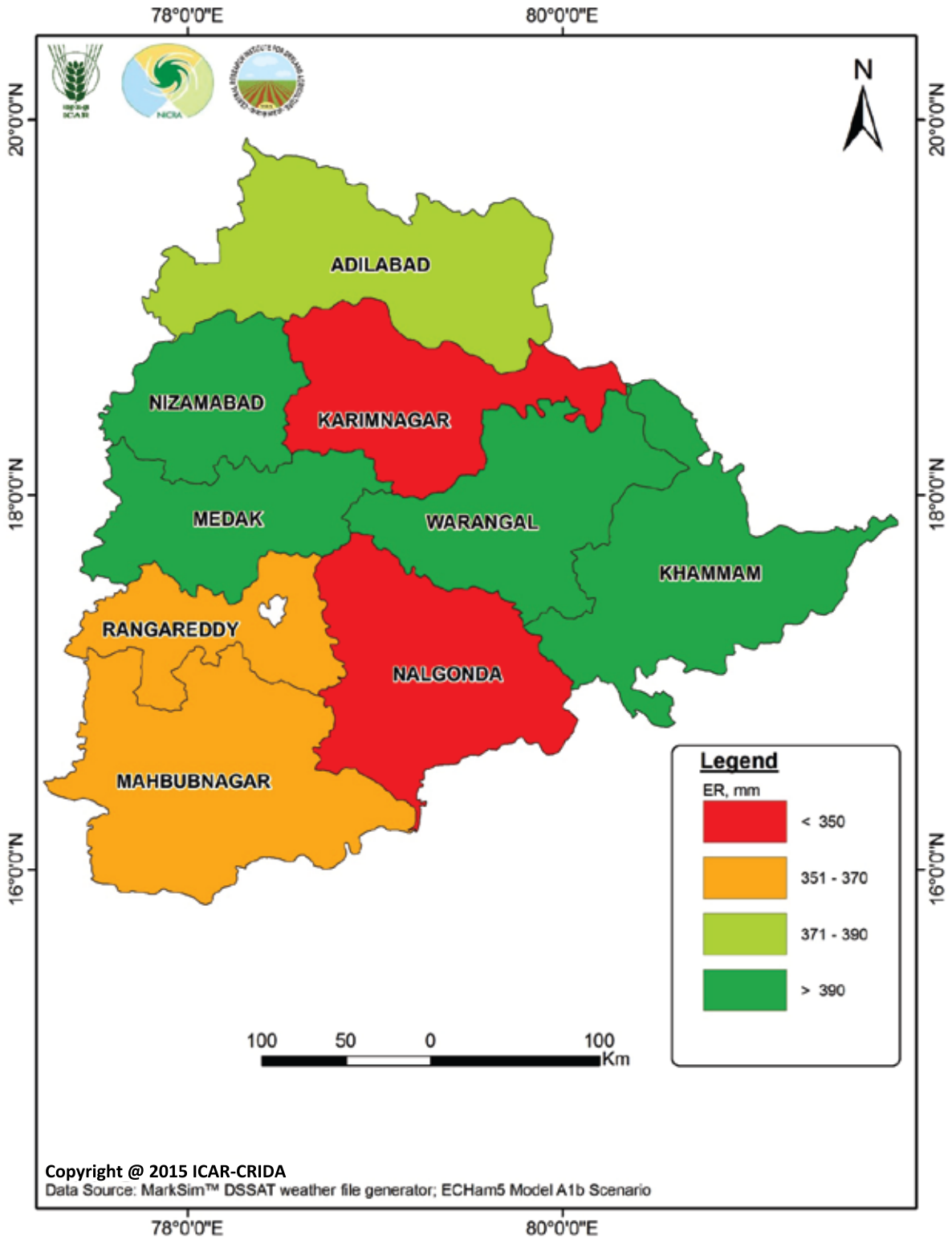

Fig.3.98 Effective rainfall (ER) during crop growth period of maize under normal sowing for the decade 2031-2040 in Telangana

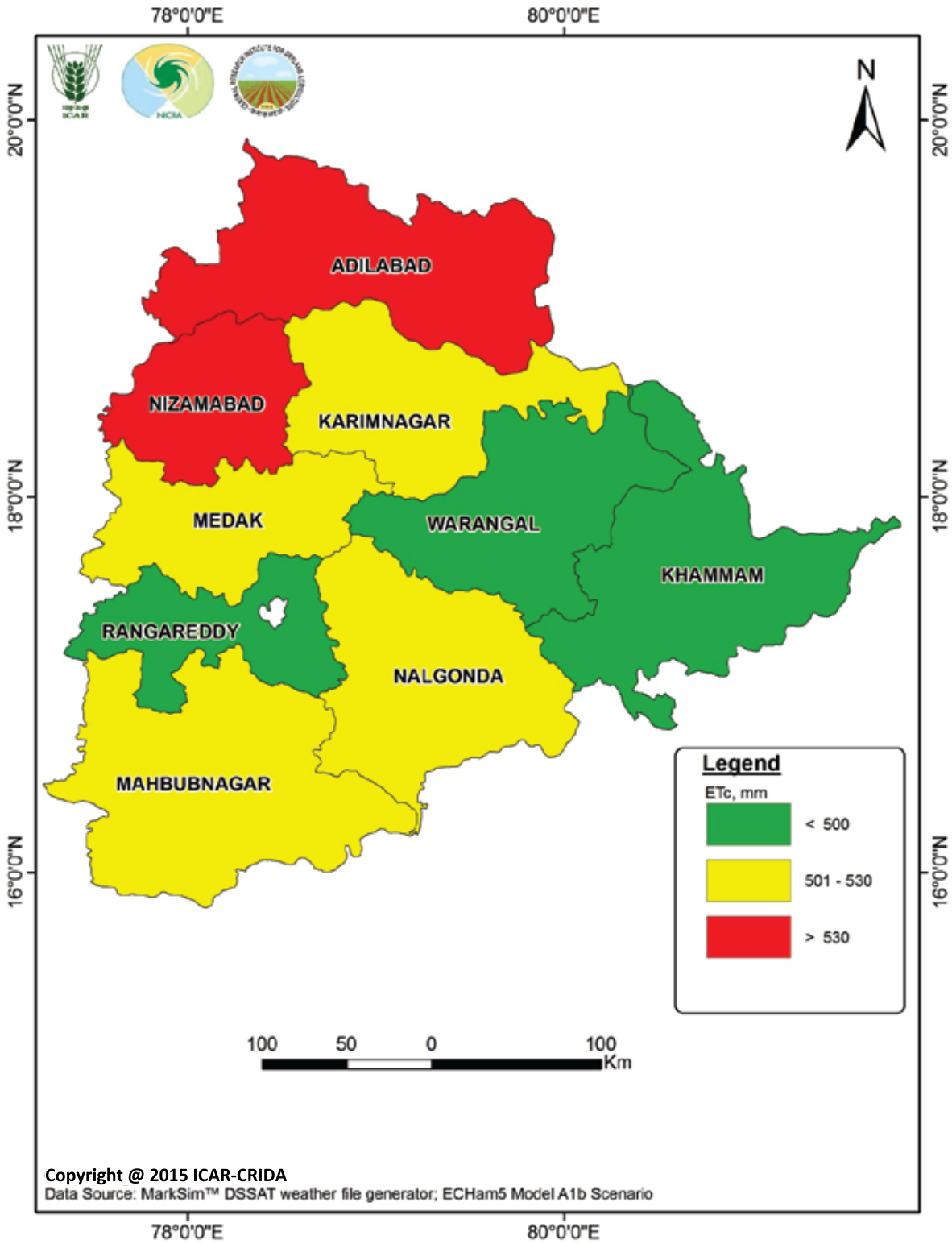

Fig.3.99 Crop evapotranspiration (ETc) during crop growth period of maize under normal sowing for the decade 2031-2040 in Telangana

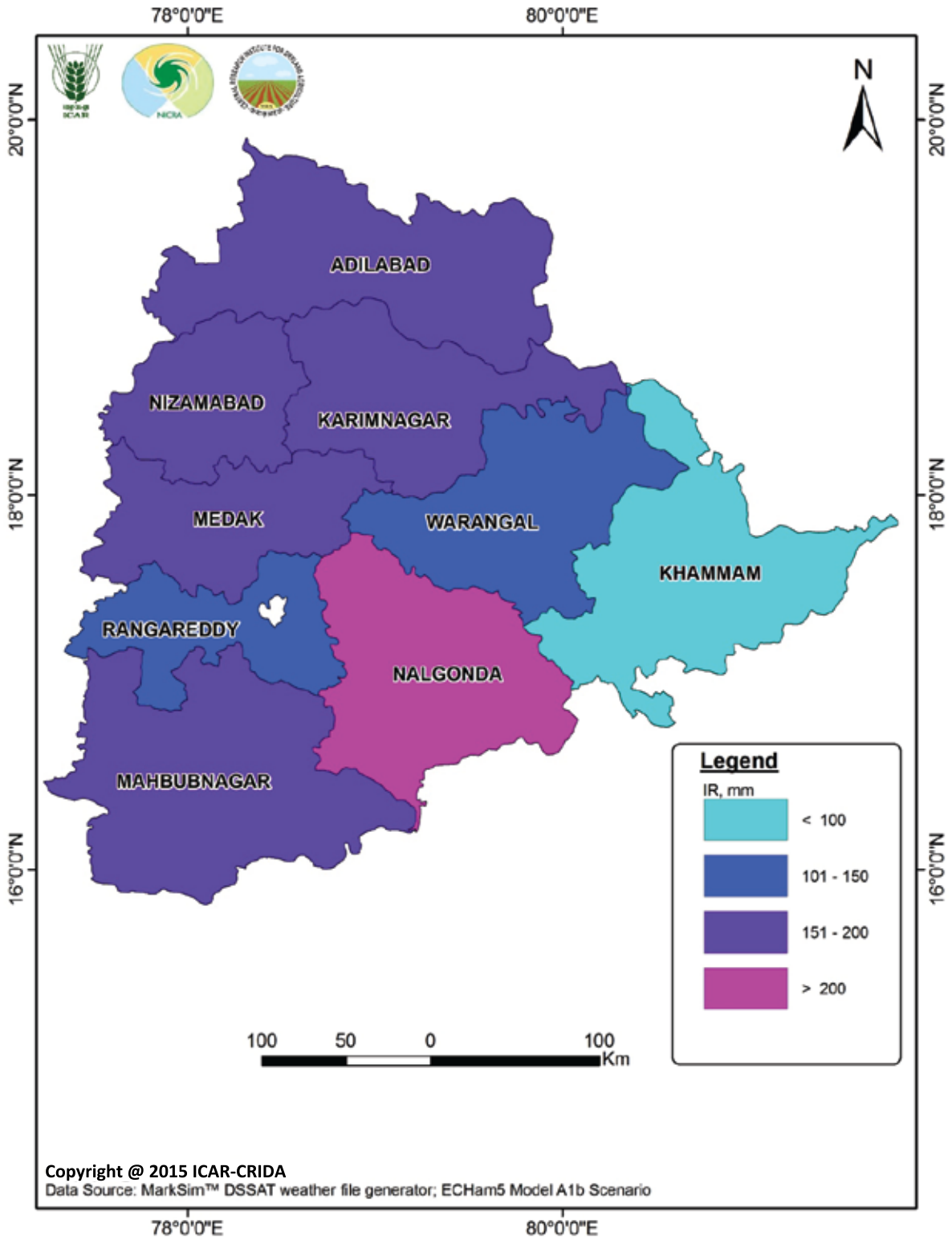

Fig.3.100 Irrigation requirement (IR) during crop growth period of maize under normal sowing for the decade 2031-2040 in Telangana

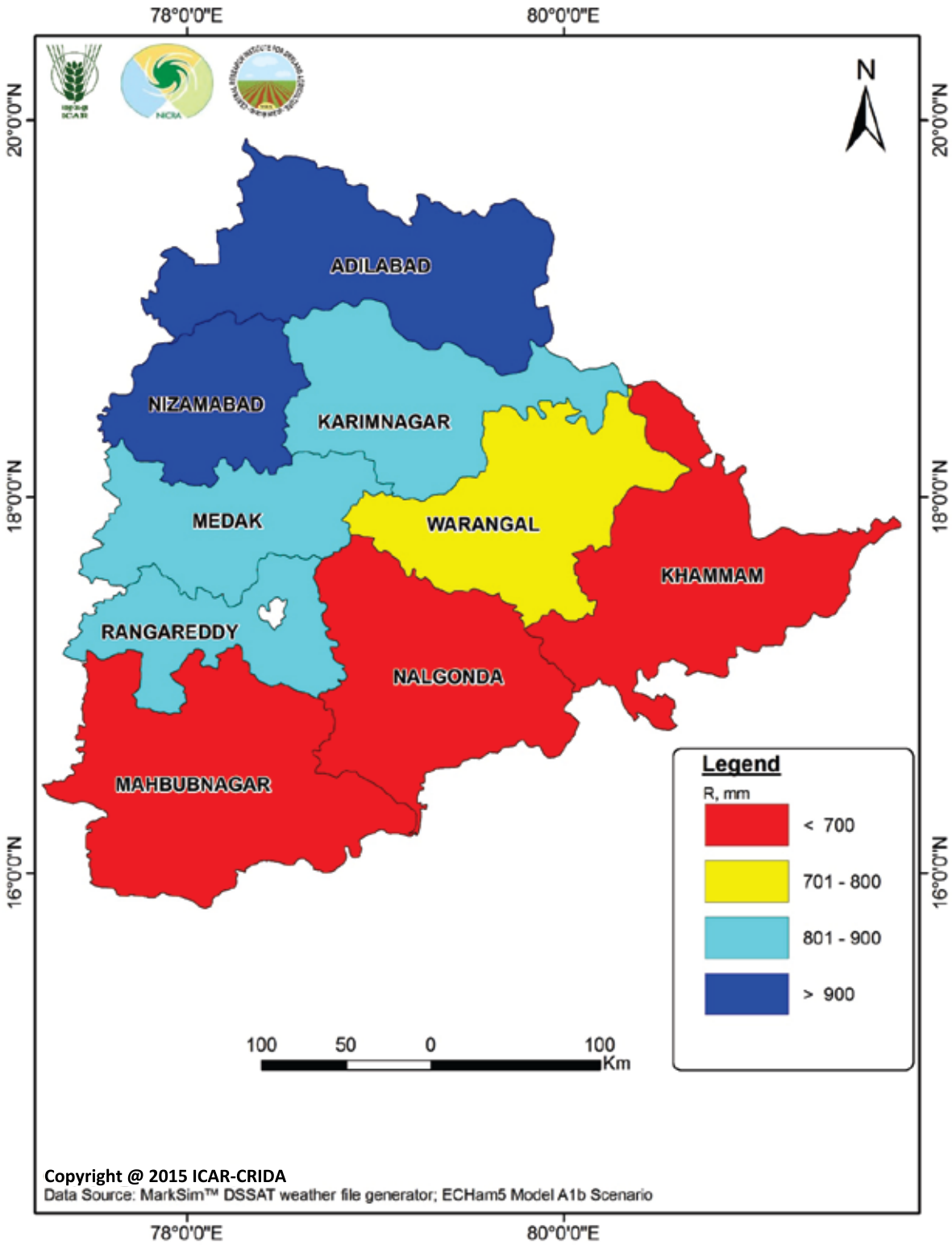

Fig.3.101 Rainfall (R) during crop growth period of maize under late sowing for the decade 2031-2040 in Telangana

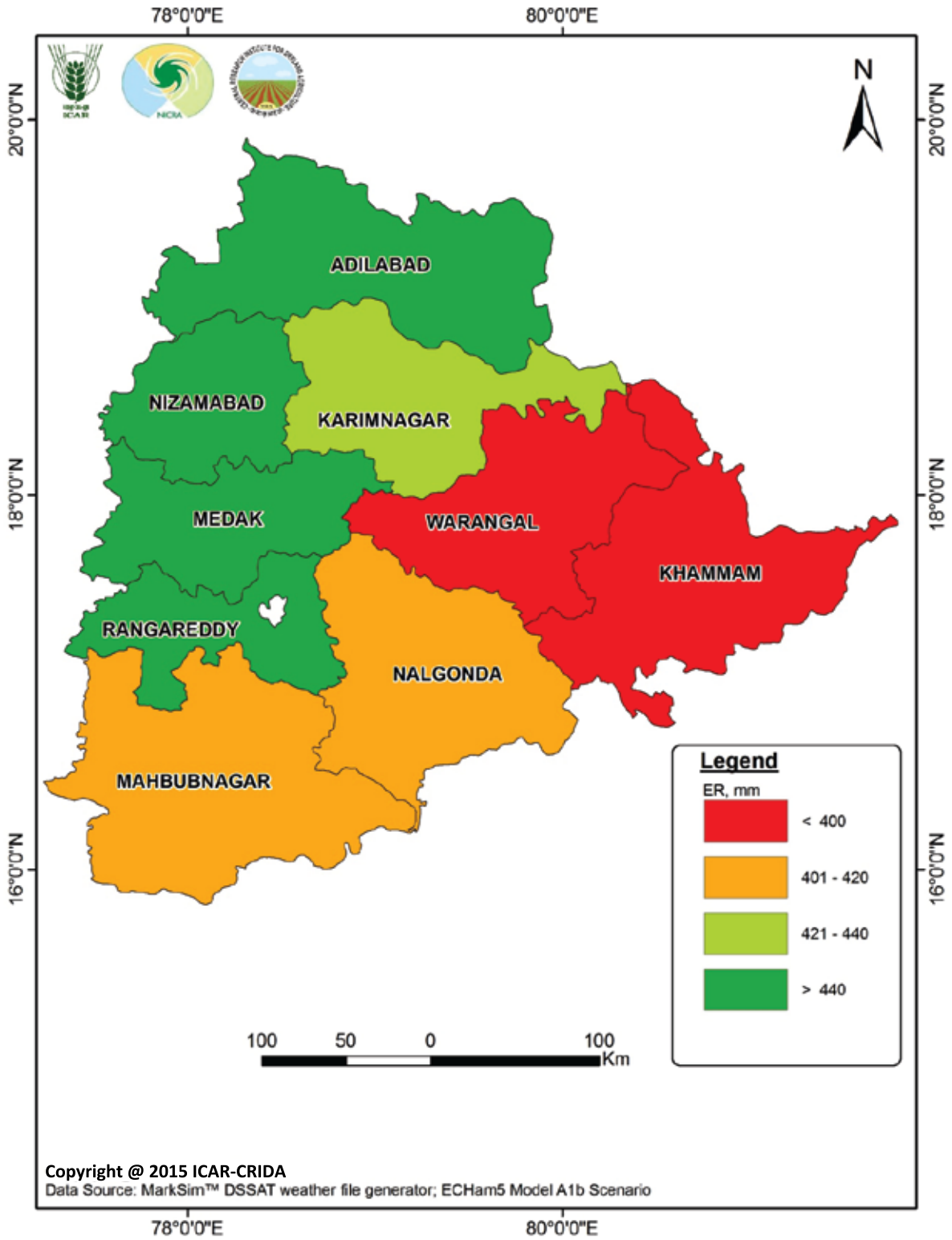

Fig.3.102 Effective rainfall (ER) during crop growth period of maize under late sowing for the decade 2031-2040 in Telangana

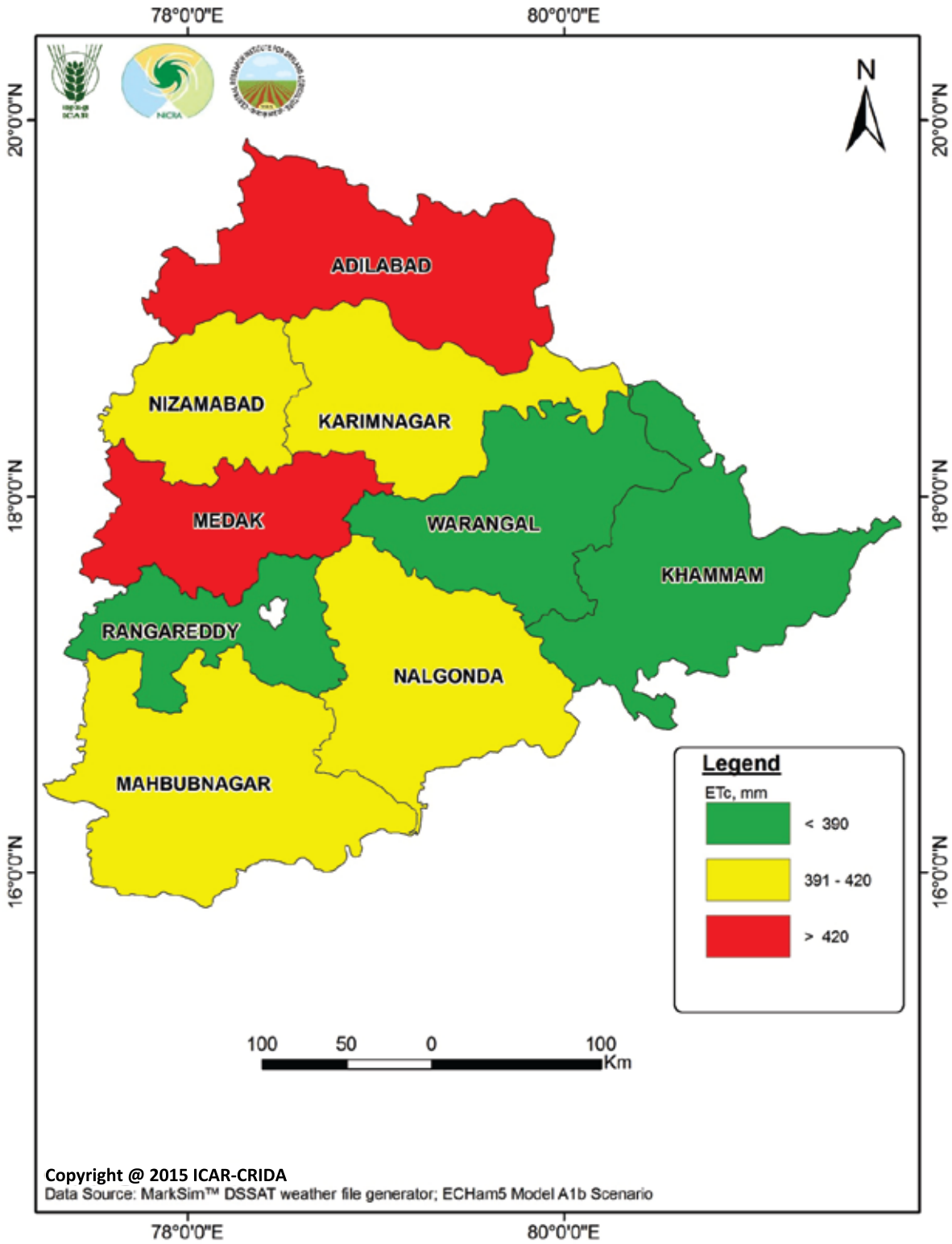

Fig.3.103 Crop evapotranspiration (ETc) during crop growth period of maize under late sowing for the decade 2031-2040 in Telangana

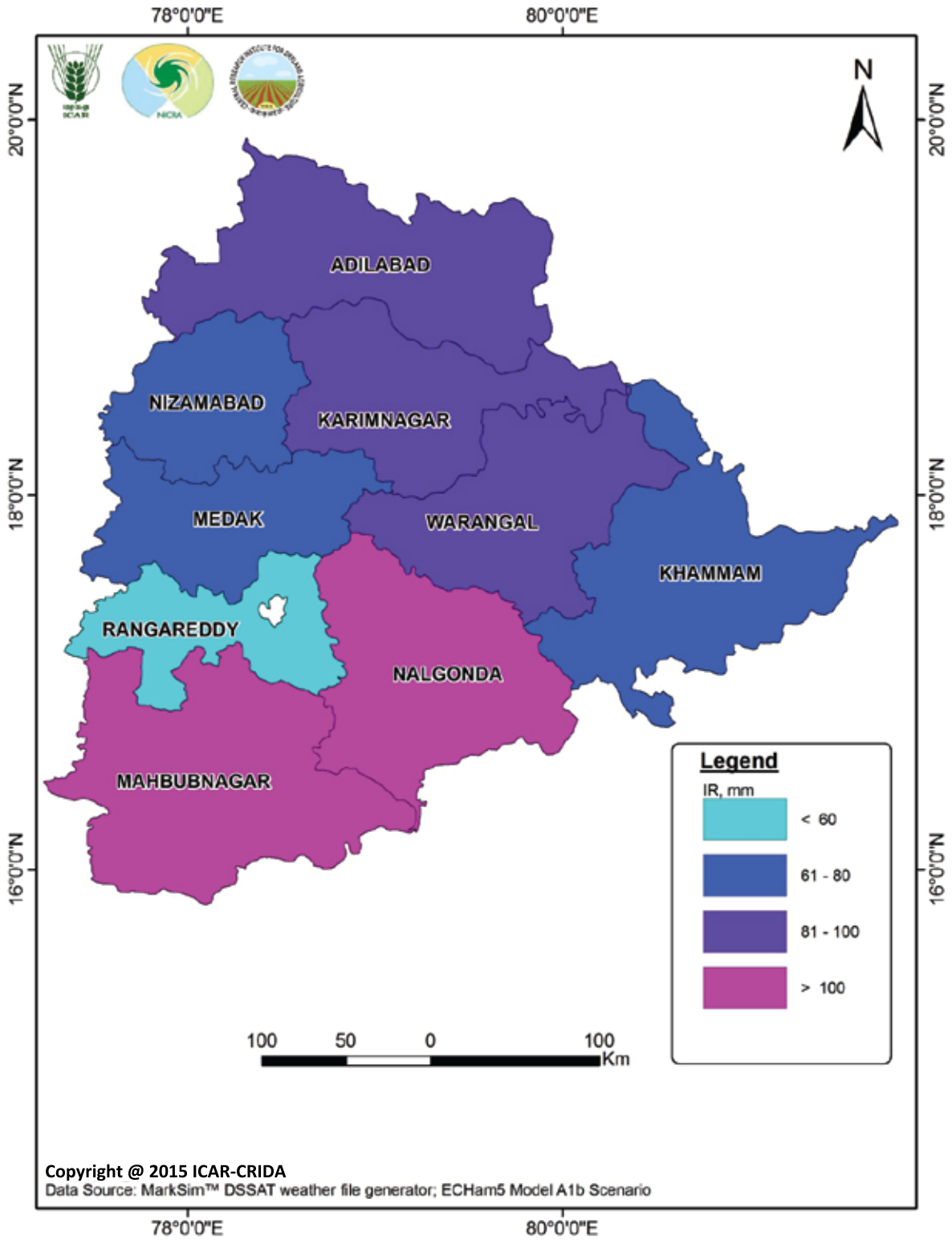

Fig.3.104 Irrigation requirement (IR) during crop growth period of maize under late sowing for the decade 2031-2040 in Telangana

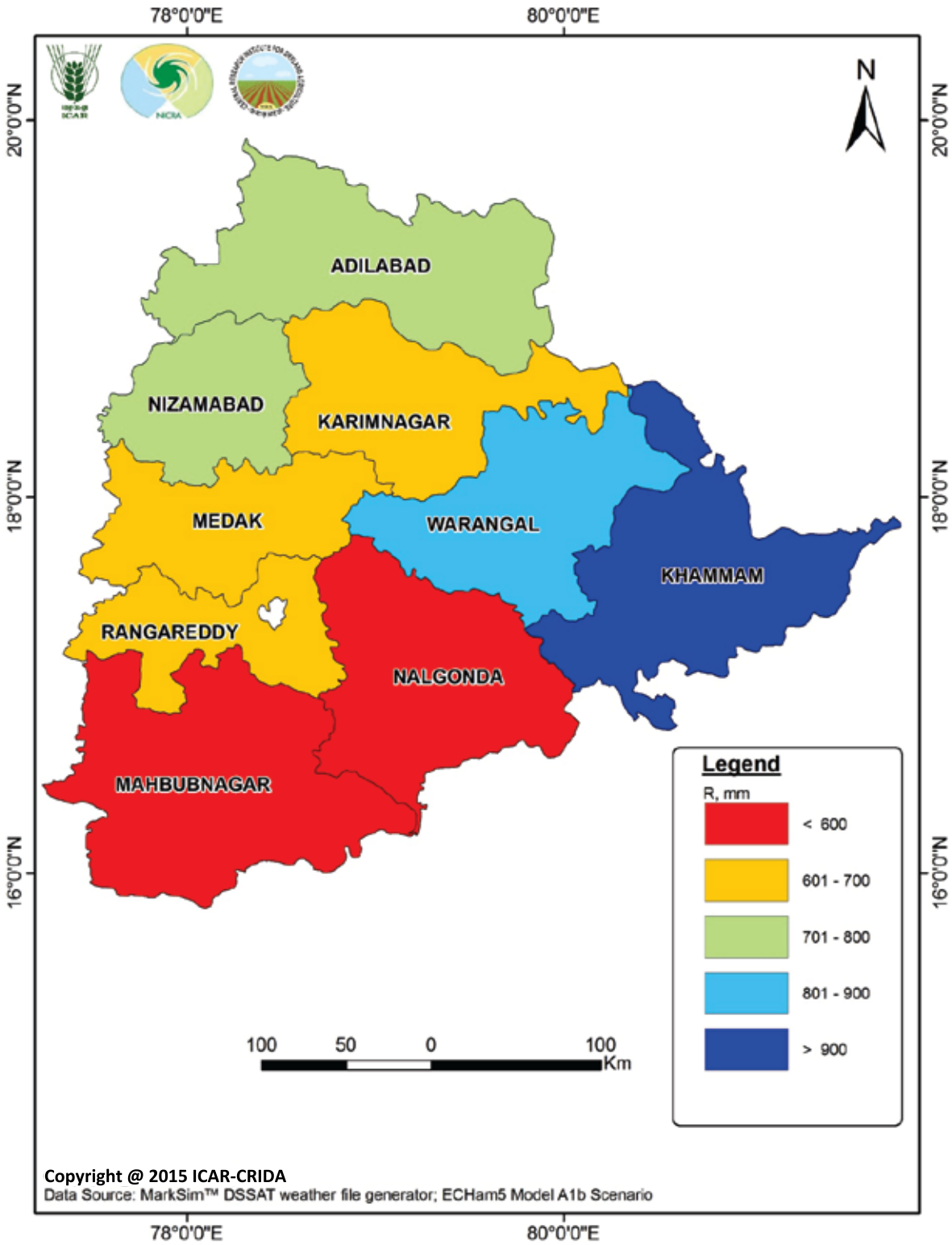

Fig.3.105 Rainfall (R) during crop growth period of maize under normal sowing for the decade 2041-2050 in Telangana

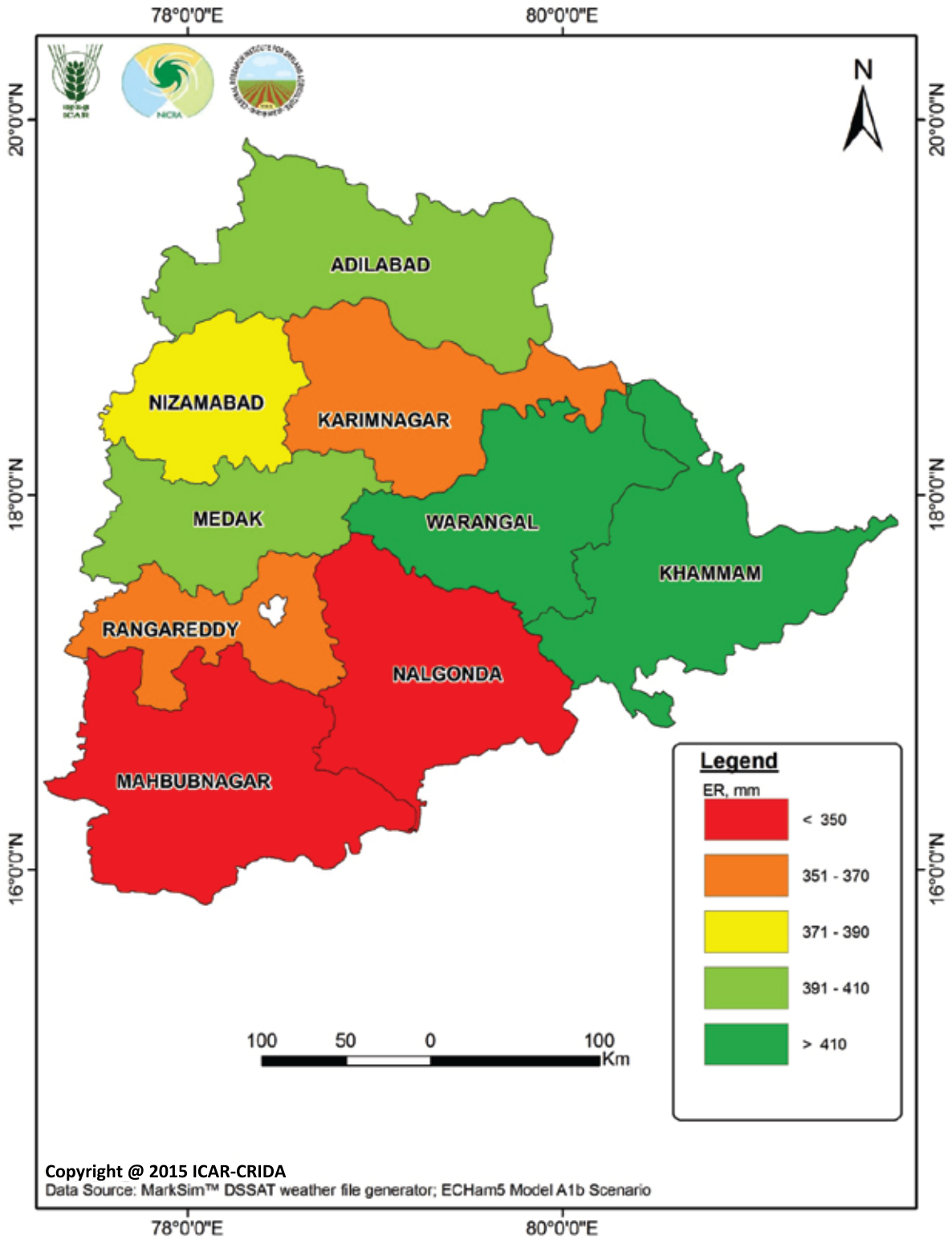

Fig.3.106 Effective rainfall (ER) during crop growth period of maize under normal sowing for the decade 2041-2050 in Telangana

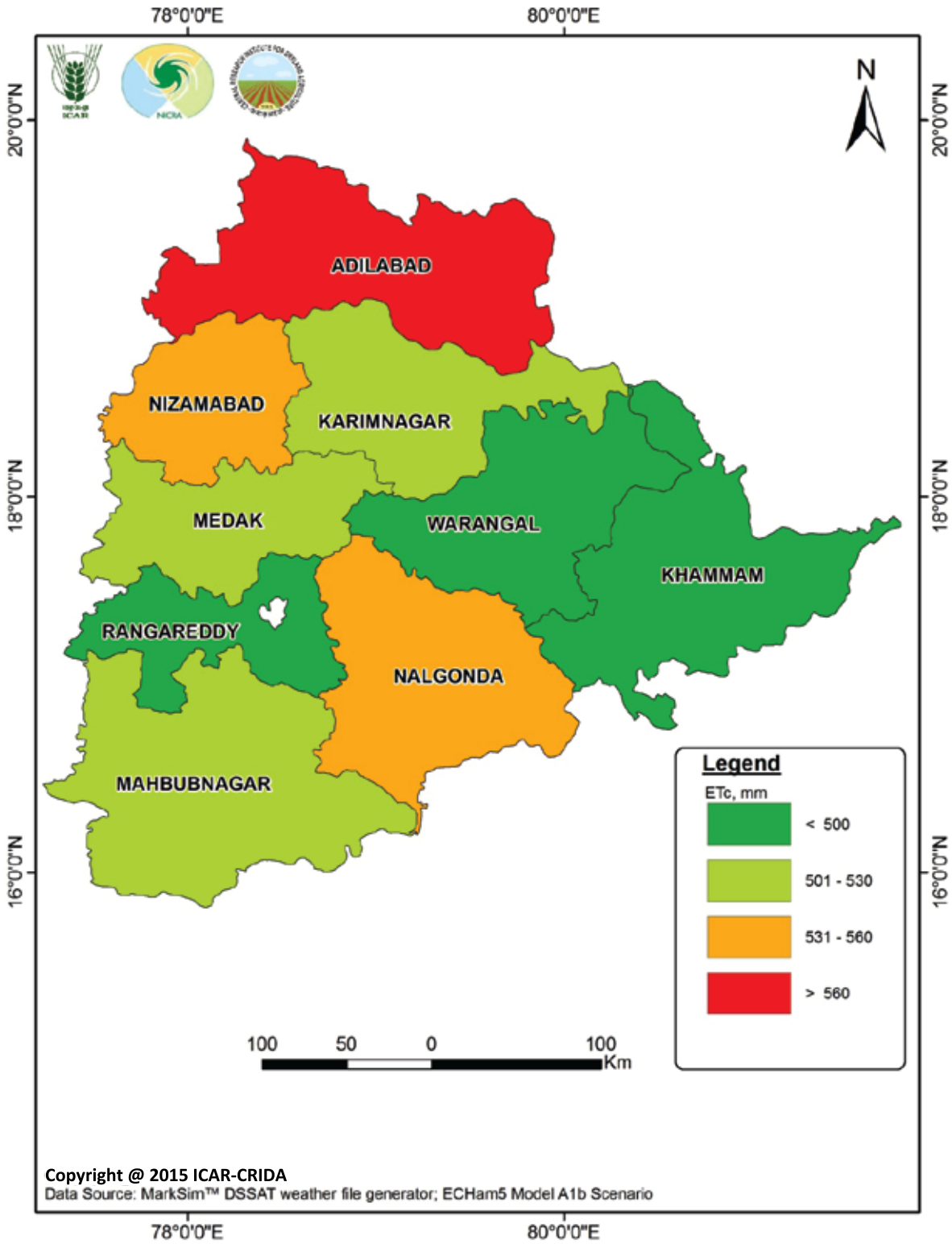

Fig.3.107 Crop evapotranspiration (ETc) during crop growth period of maize under normal sowing for the decade 2041-2050 in Telangana

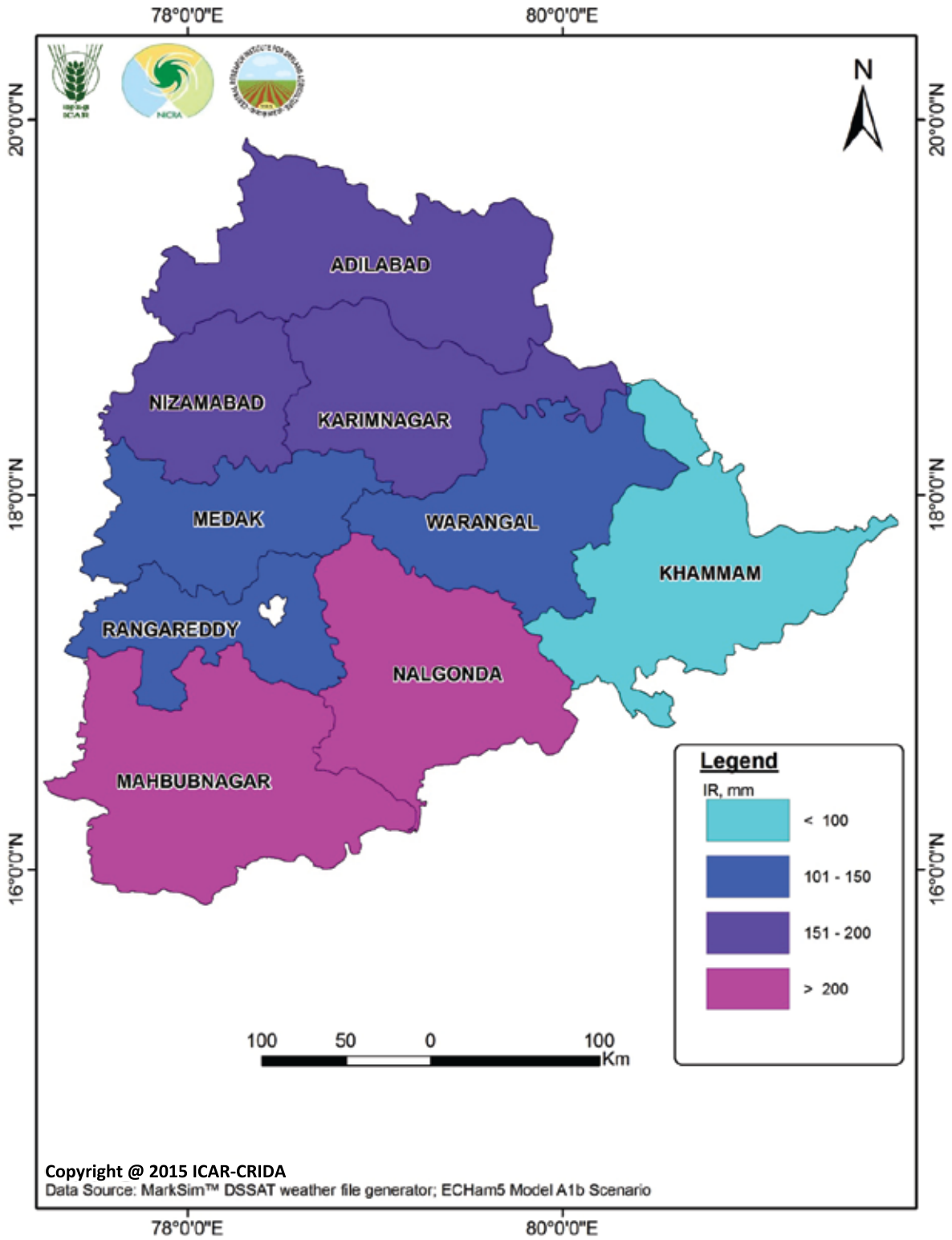

Fig.3.108 Irrigation requirement (IR) during crop growth period of maize under normal sowing for the decade 2041-2050 in Telangana

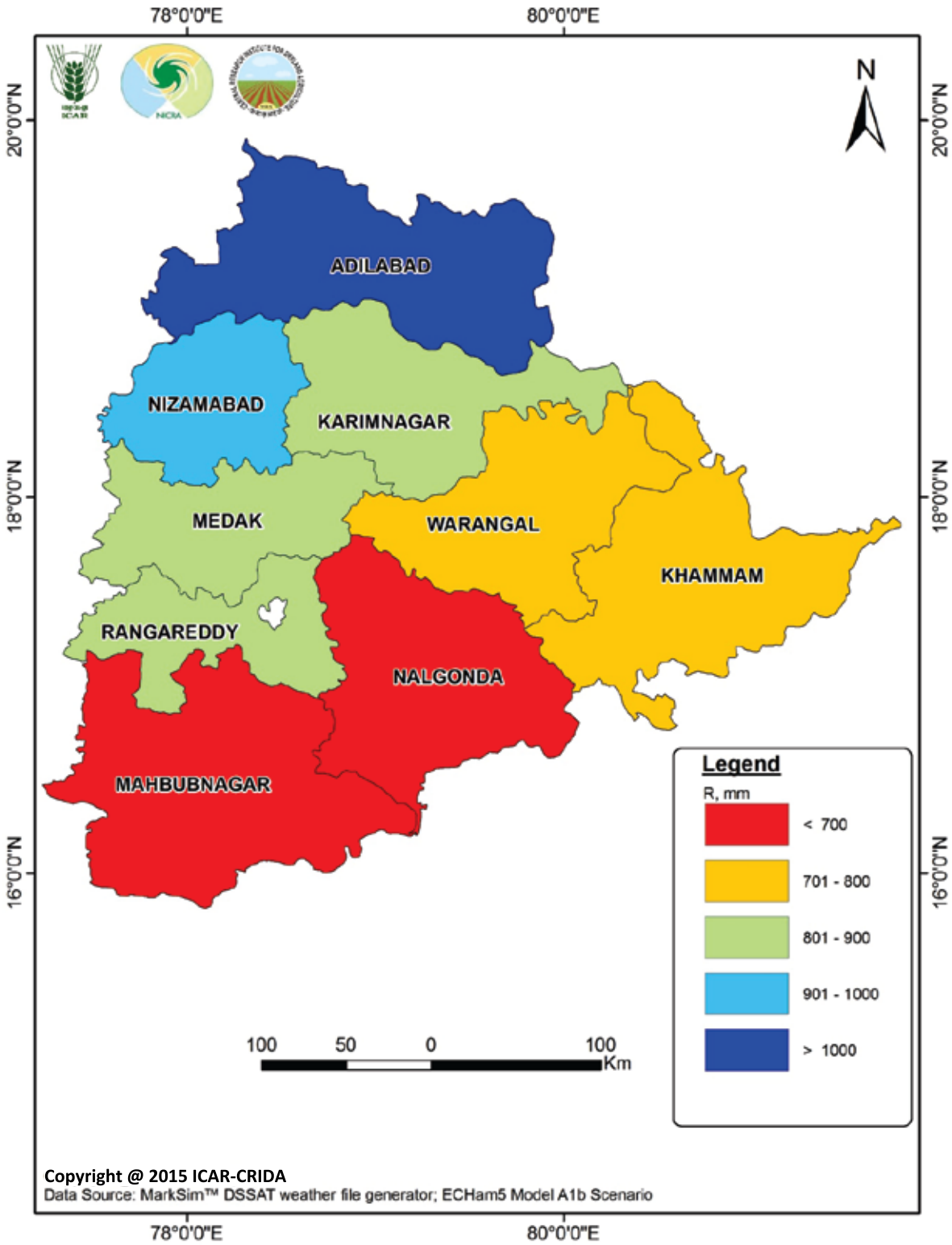

Fig.3.109 Rainfall (R) during crop growth period of maize under late sowing for the decade 2041-2050 in Telangana

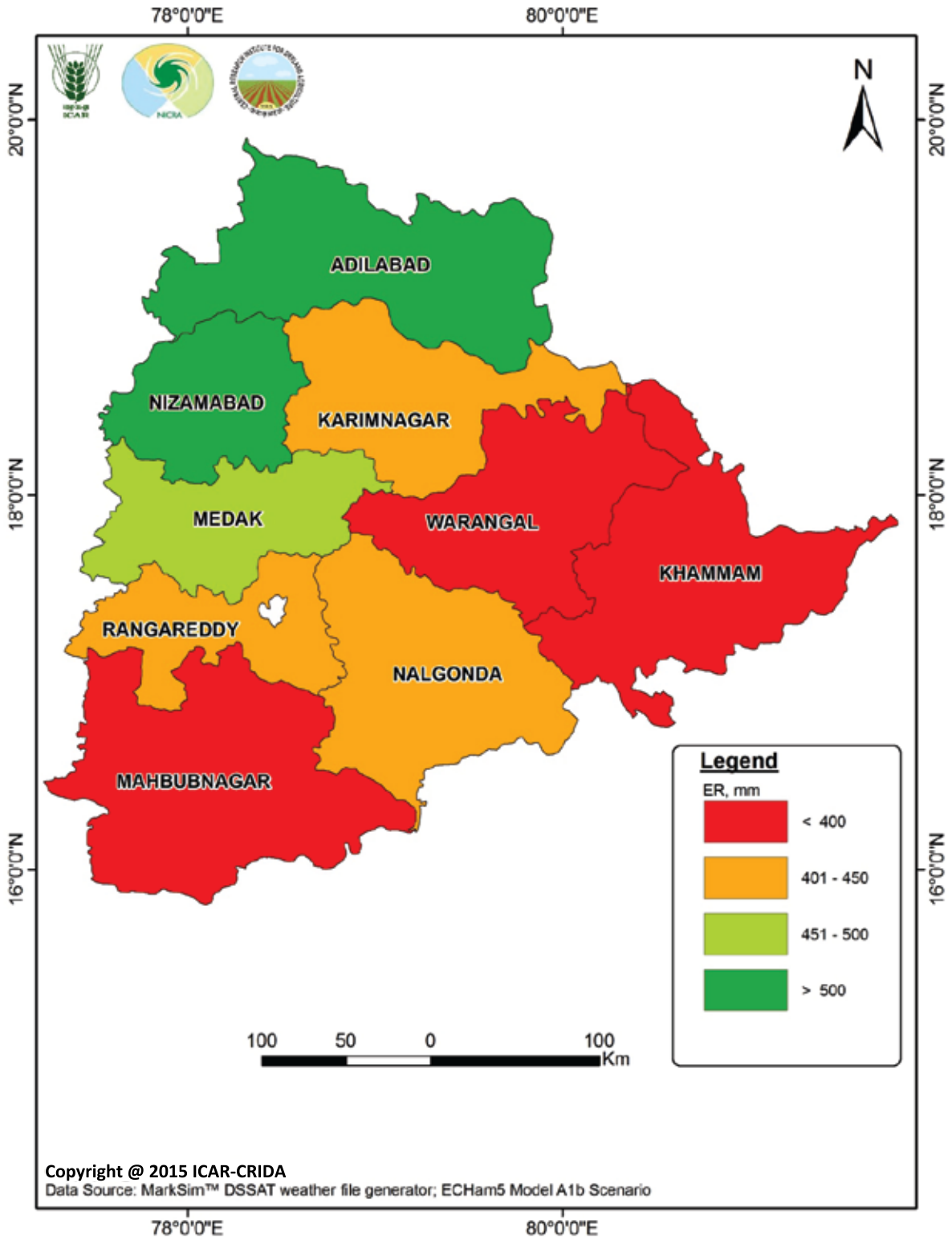

Fig.3.110 Effective rainfall (ER) during crop growth period of maize under late sowing for the decade 2041-2050 in Telangana

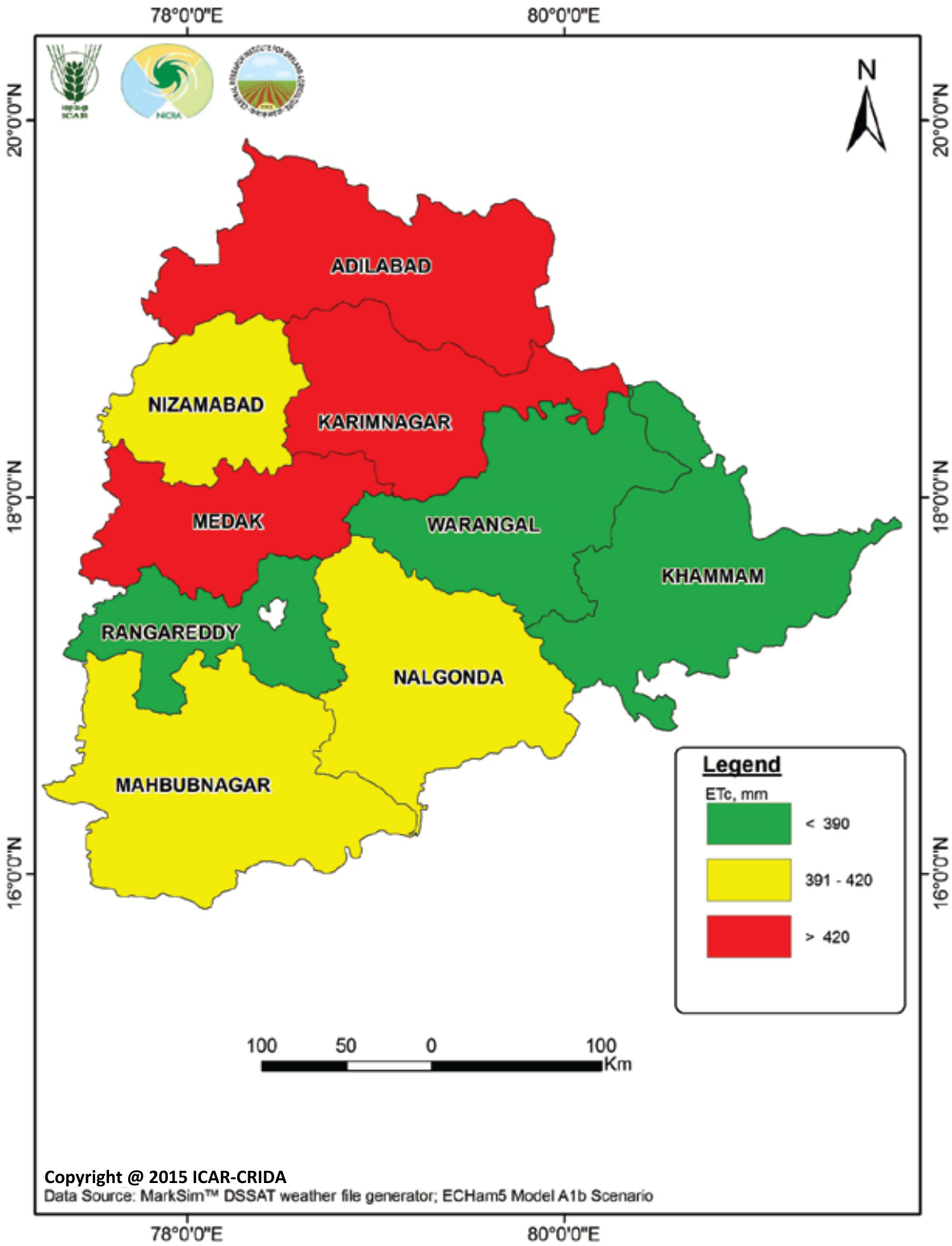

Fig.3.111 Crop evapotranspiration (ETc) during crop growth period of maize under late sowing for the decade 2041-2050 in Telangana

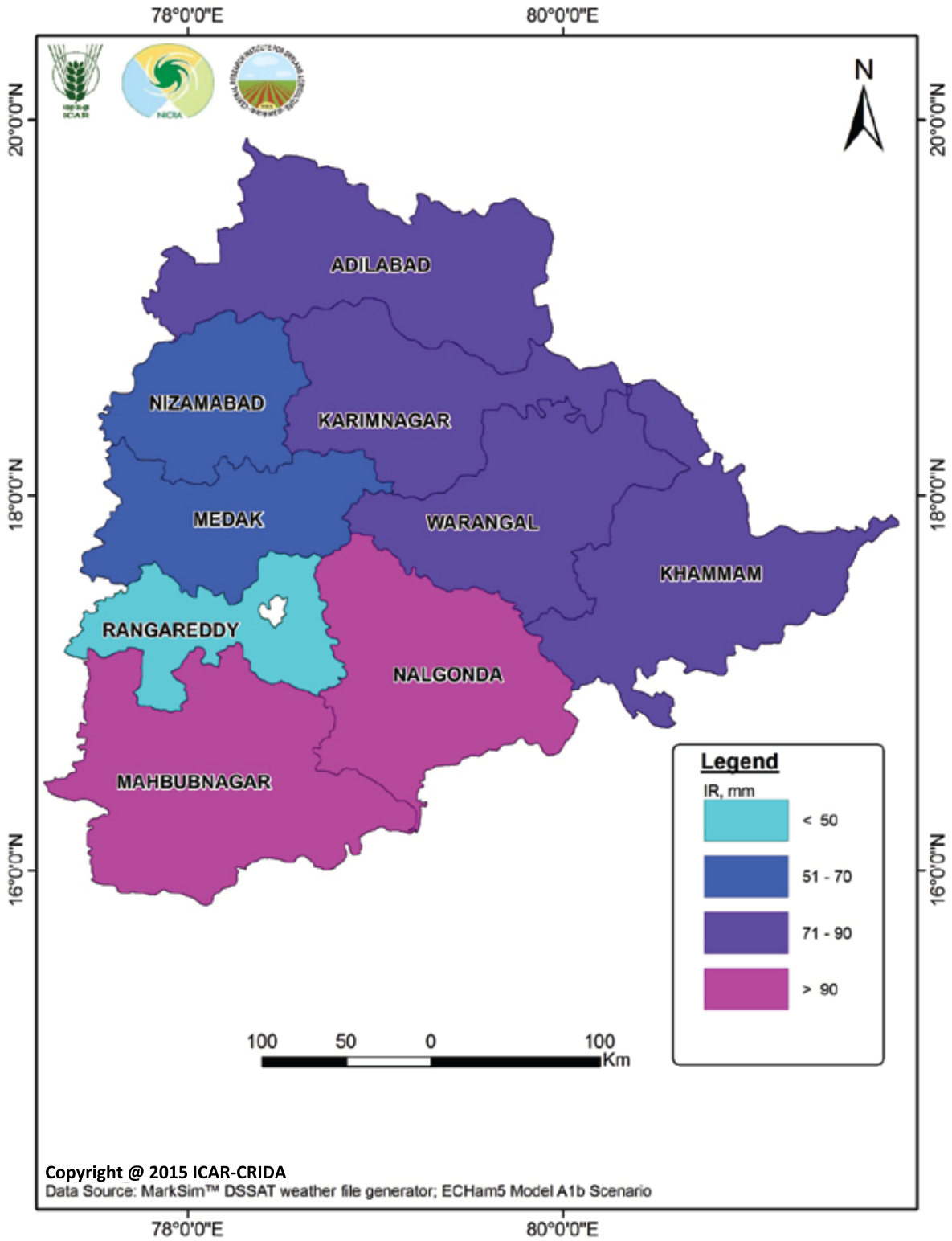

Fig.3.112 Irrigation requirement (IR) during crop growth period of maize under late sowing for the decade 2041-2050 in Telangana

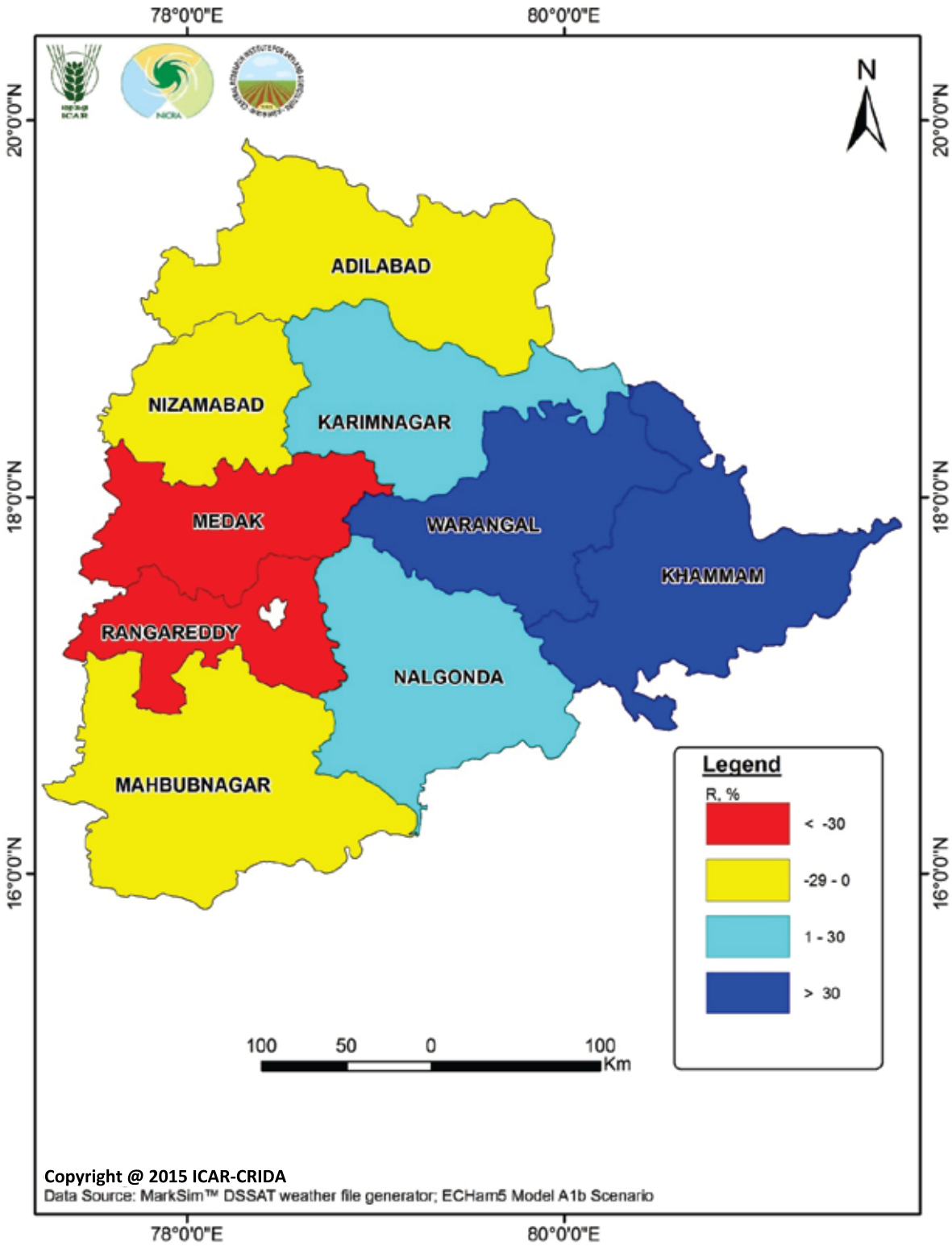

Fig.3.113 Percent decadal (2011-2020) deviation of rainfall (R) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

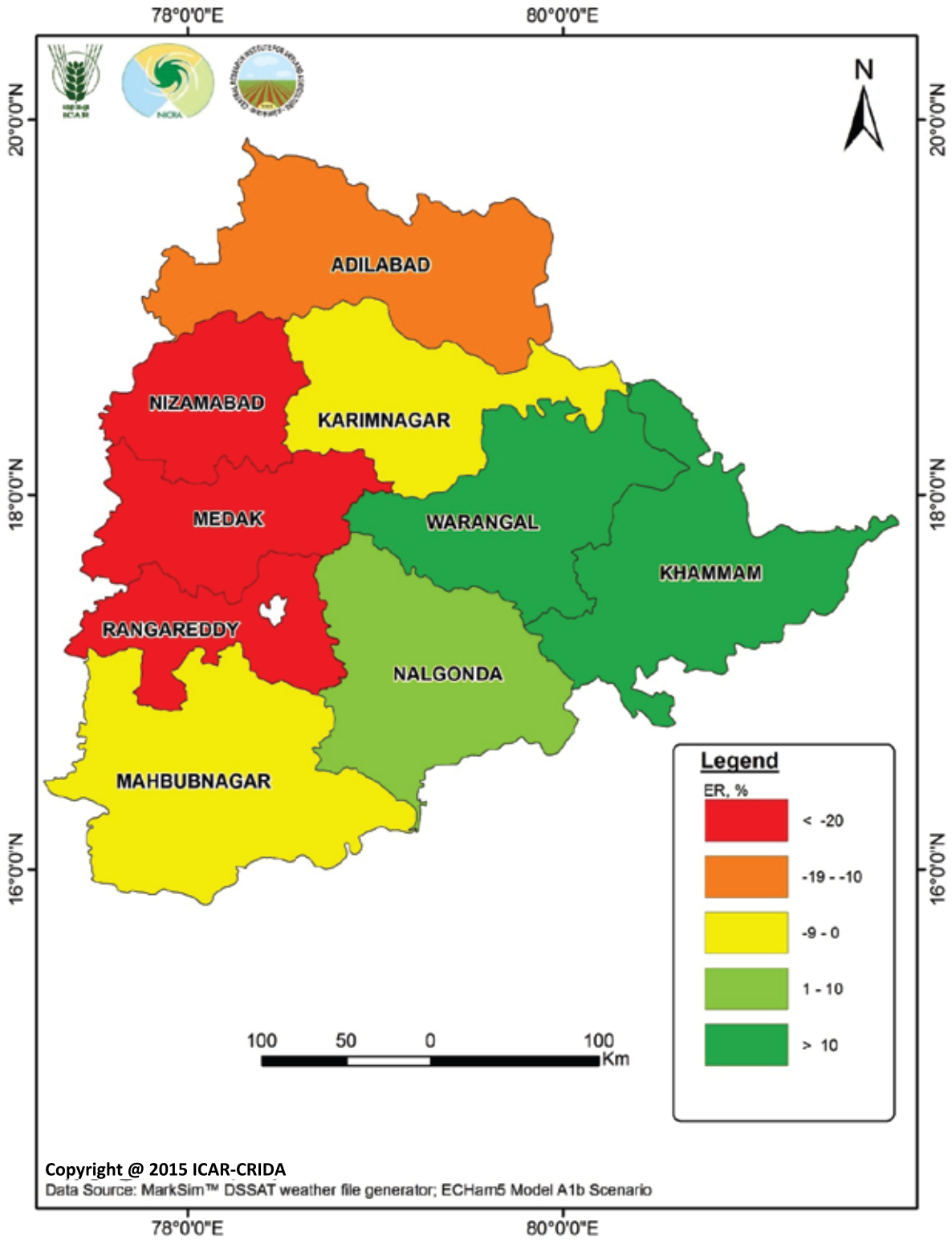

Fig.3.114 Percent decadal (2011-2020) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

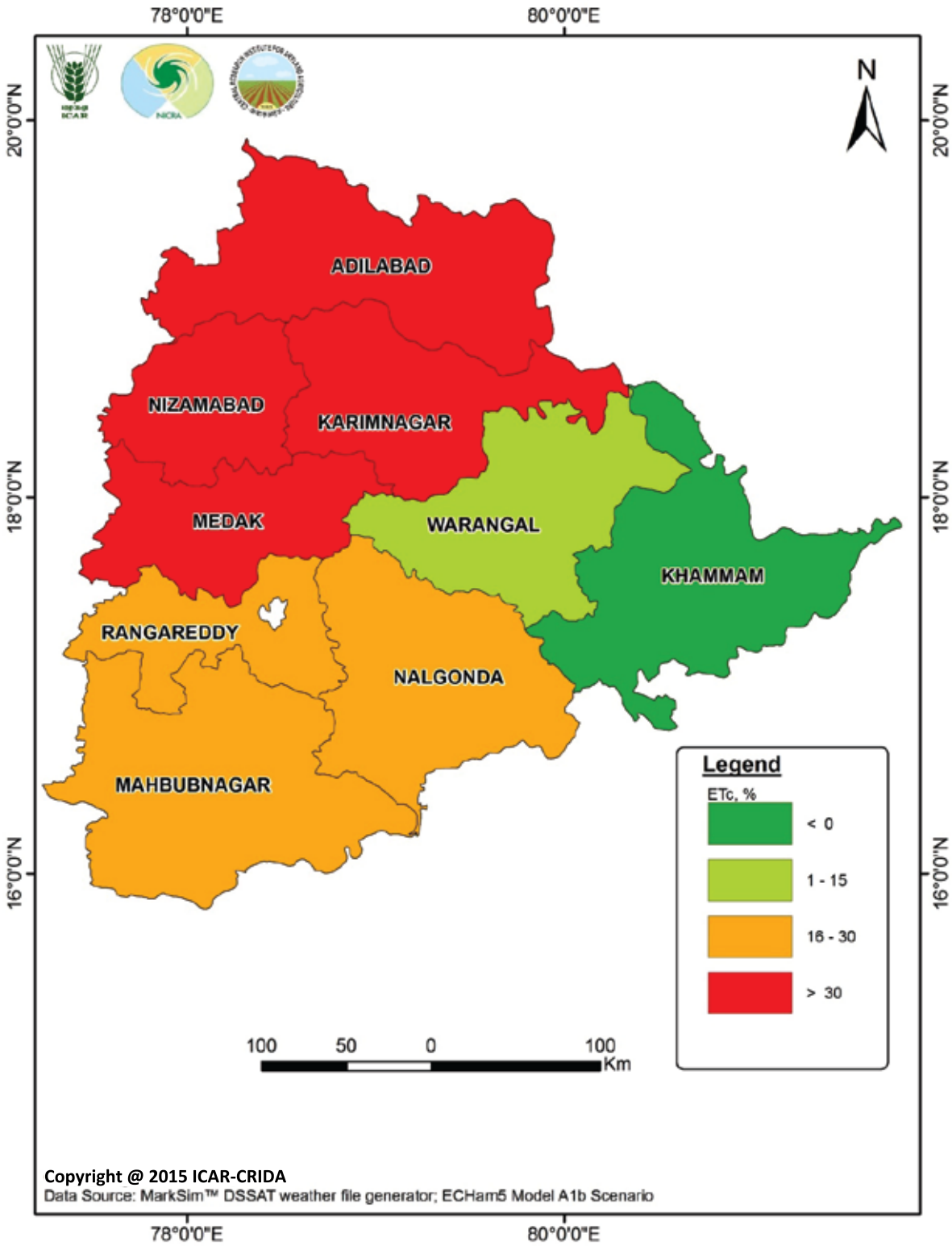

Fig.3.115 Percent decadal (2011-2020) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

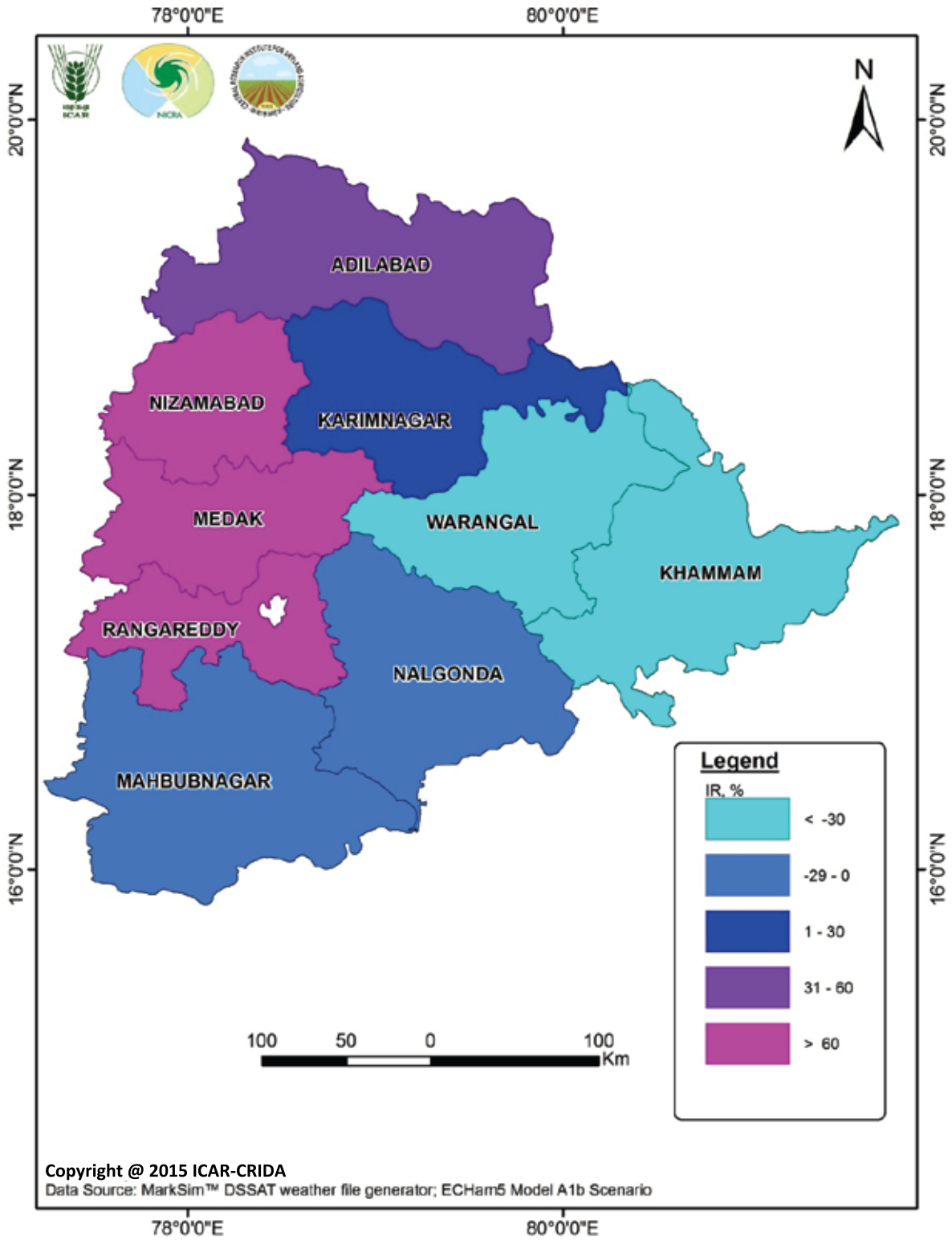

Fig.3.116 Percent decadal (2011-2020) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

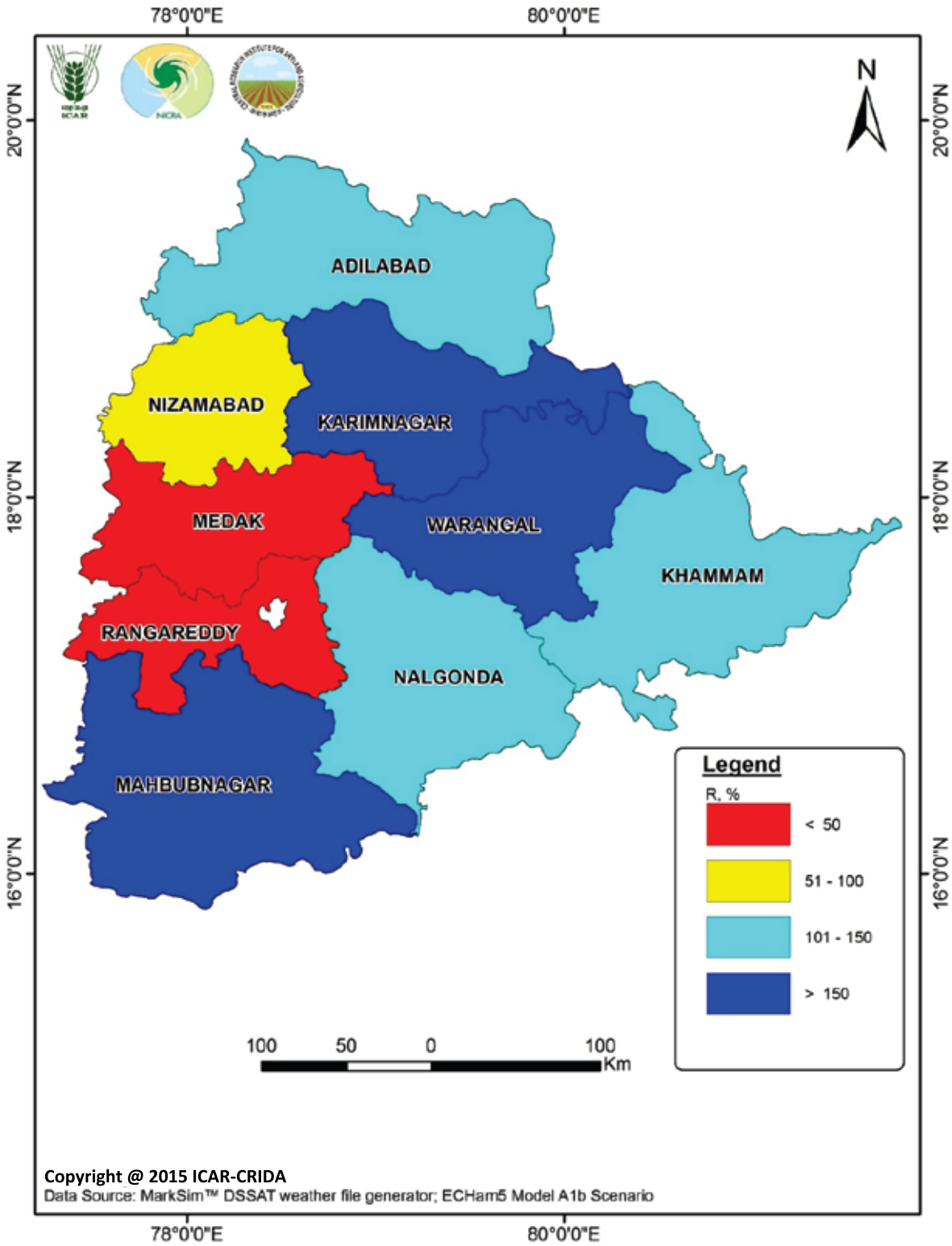

Fig.3.117 Percent decadal (2011-2020) deviation of rainfall (R) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

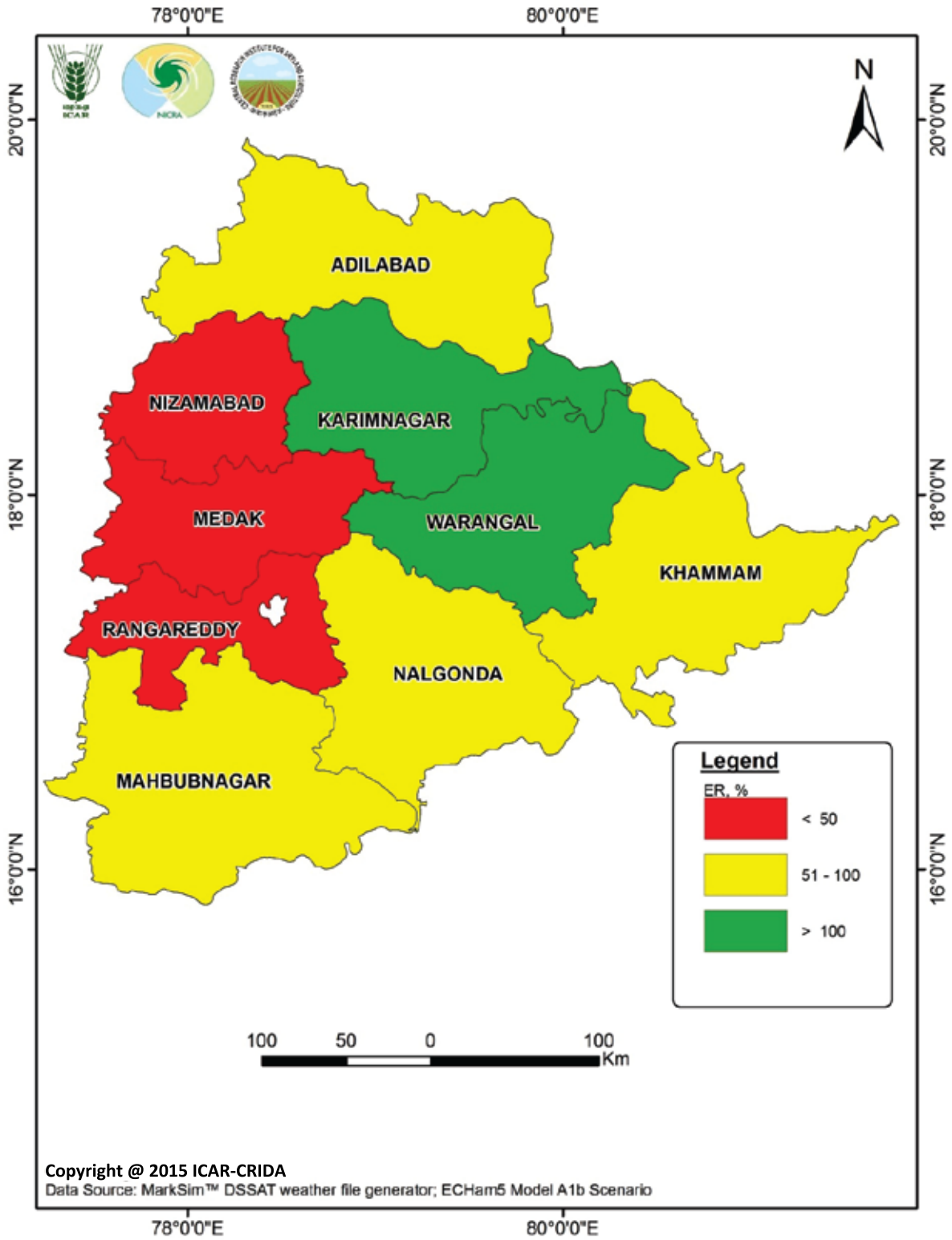

Fig.3.118 Percent decadal (2011-2020) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

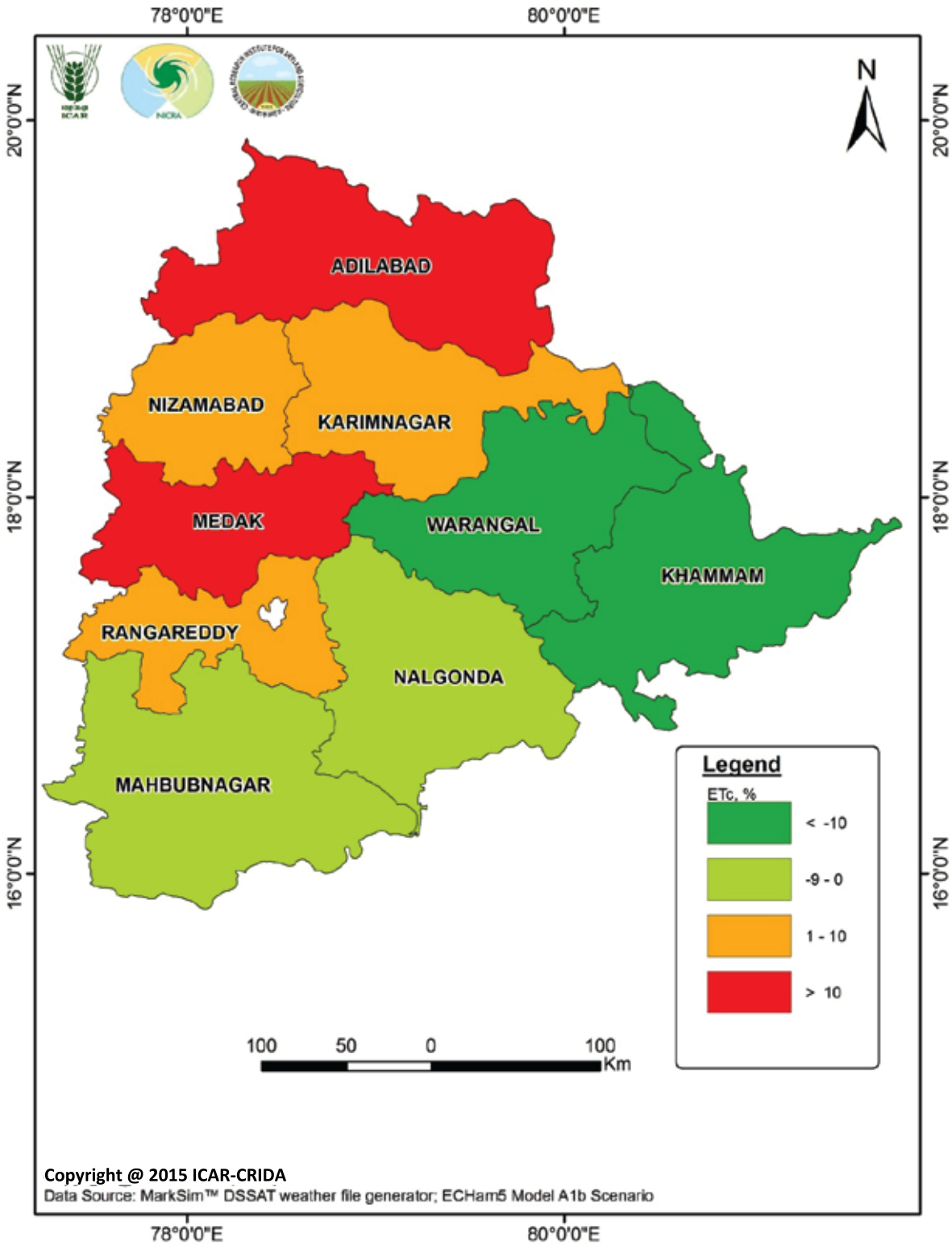

Fig.3.119 Percent decadal (2011-2020) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

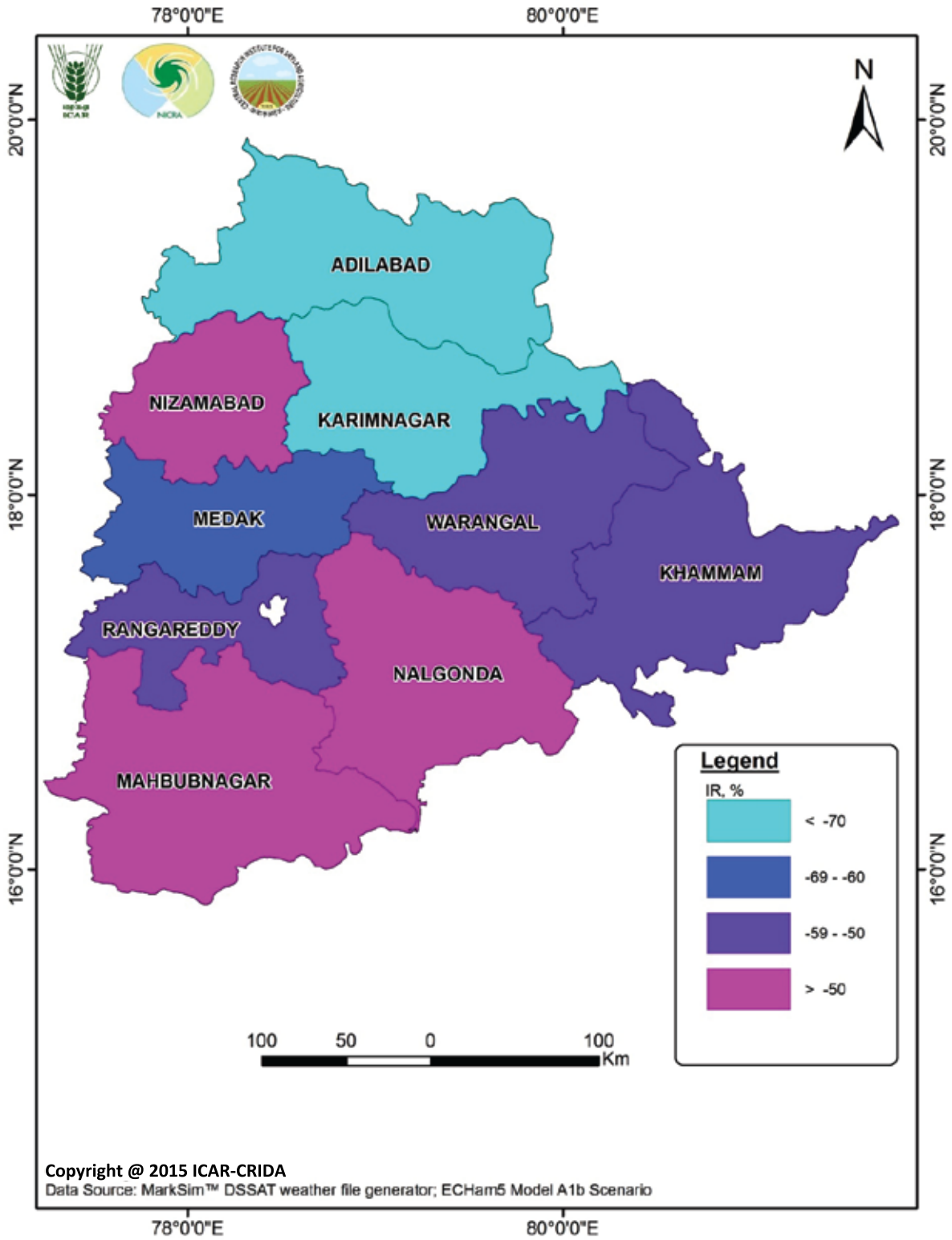

Fig.3.120 Percent decadal (2011-2020) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

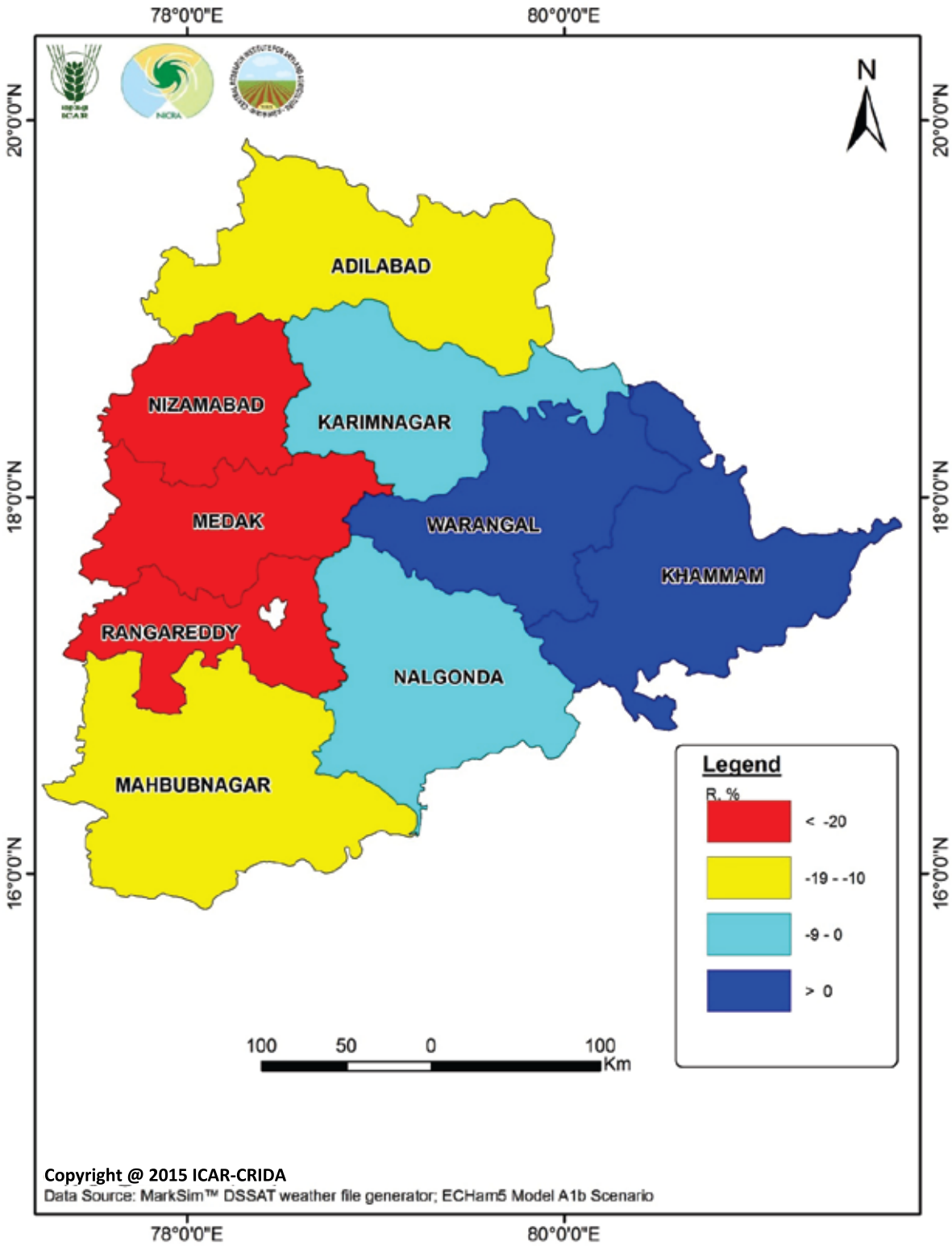

Fig.3.121 Percent decadal (2021-2030) deviation of rainfall (R) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

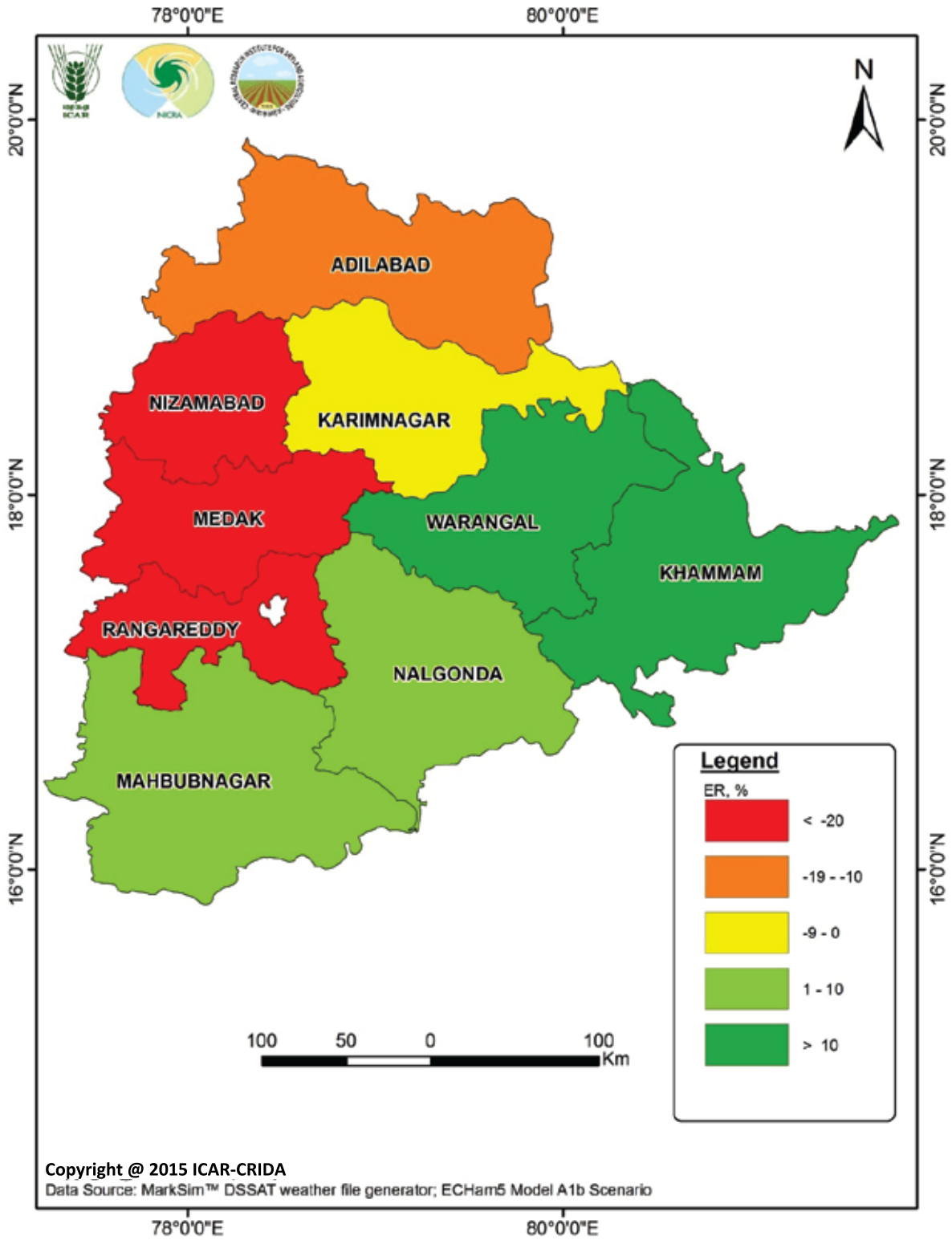

Fig.3.122 Percent decadal (2021-2030) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

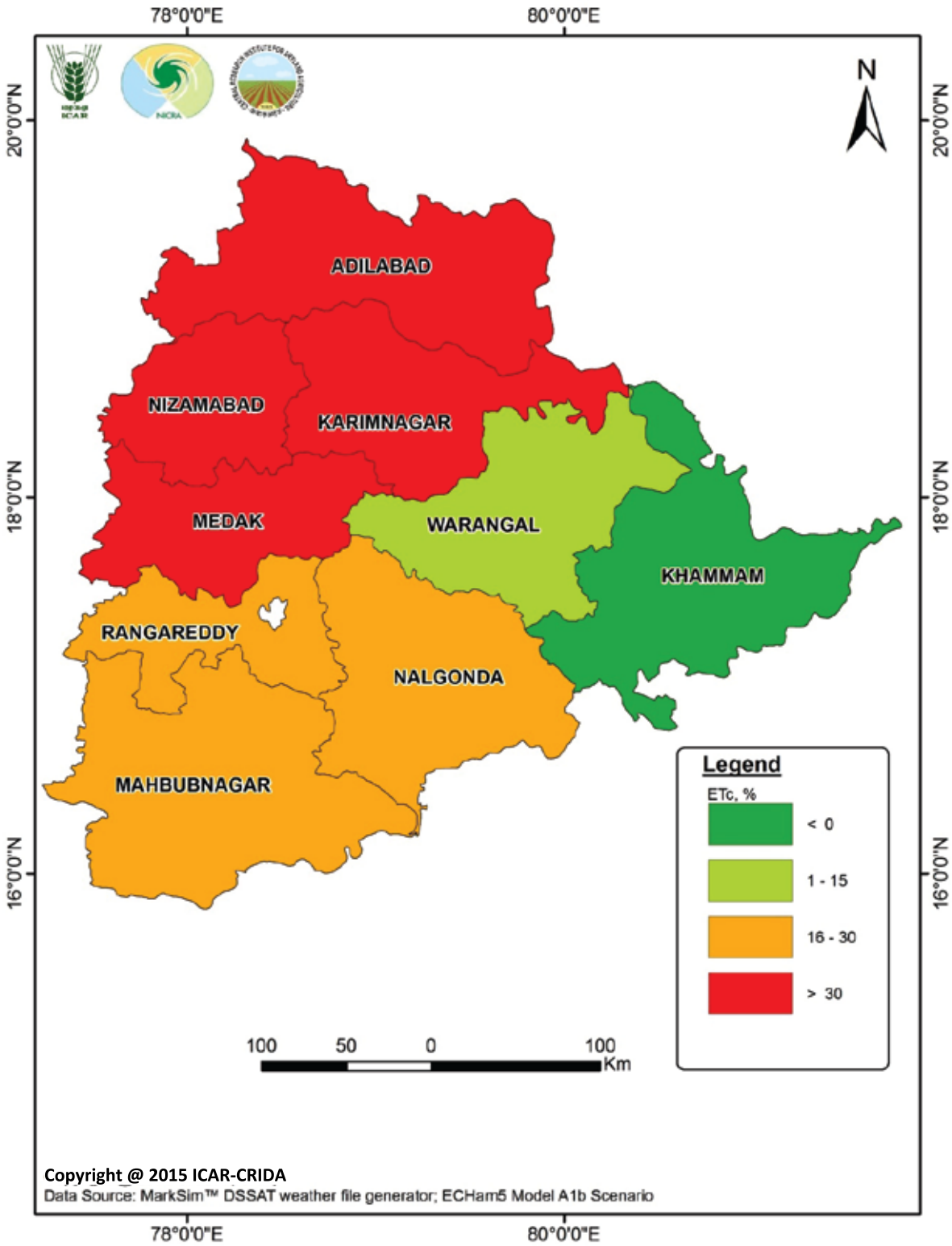

Fig.3.123 Percent decadal (2021-2030) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

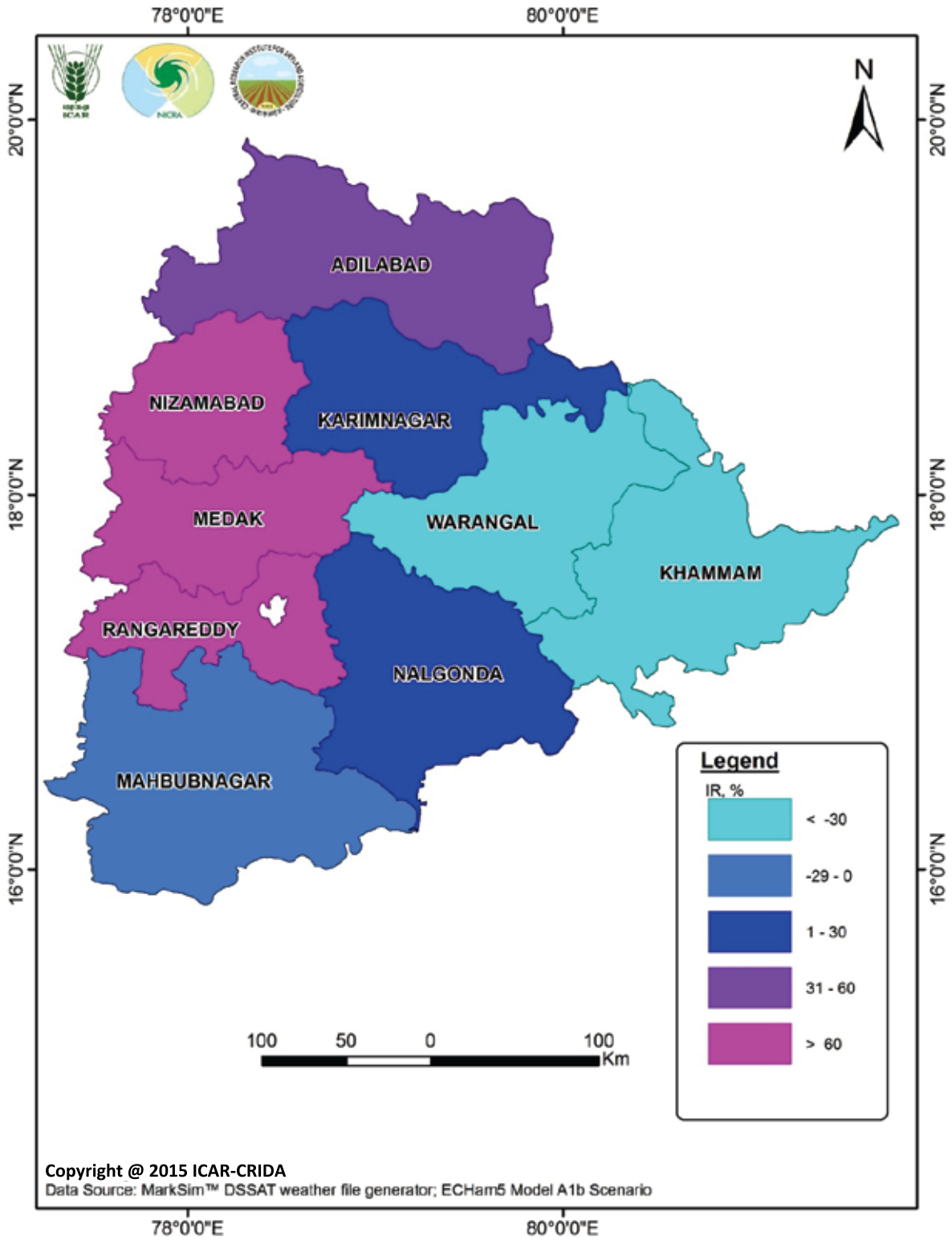

Fig.3.124 Percent decadal (2021-2030) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

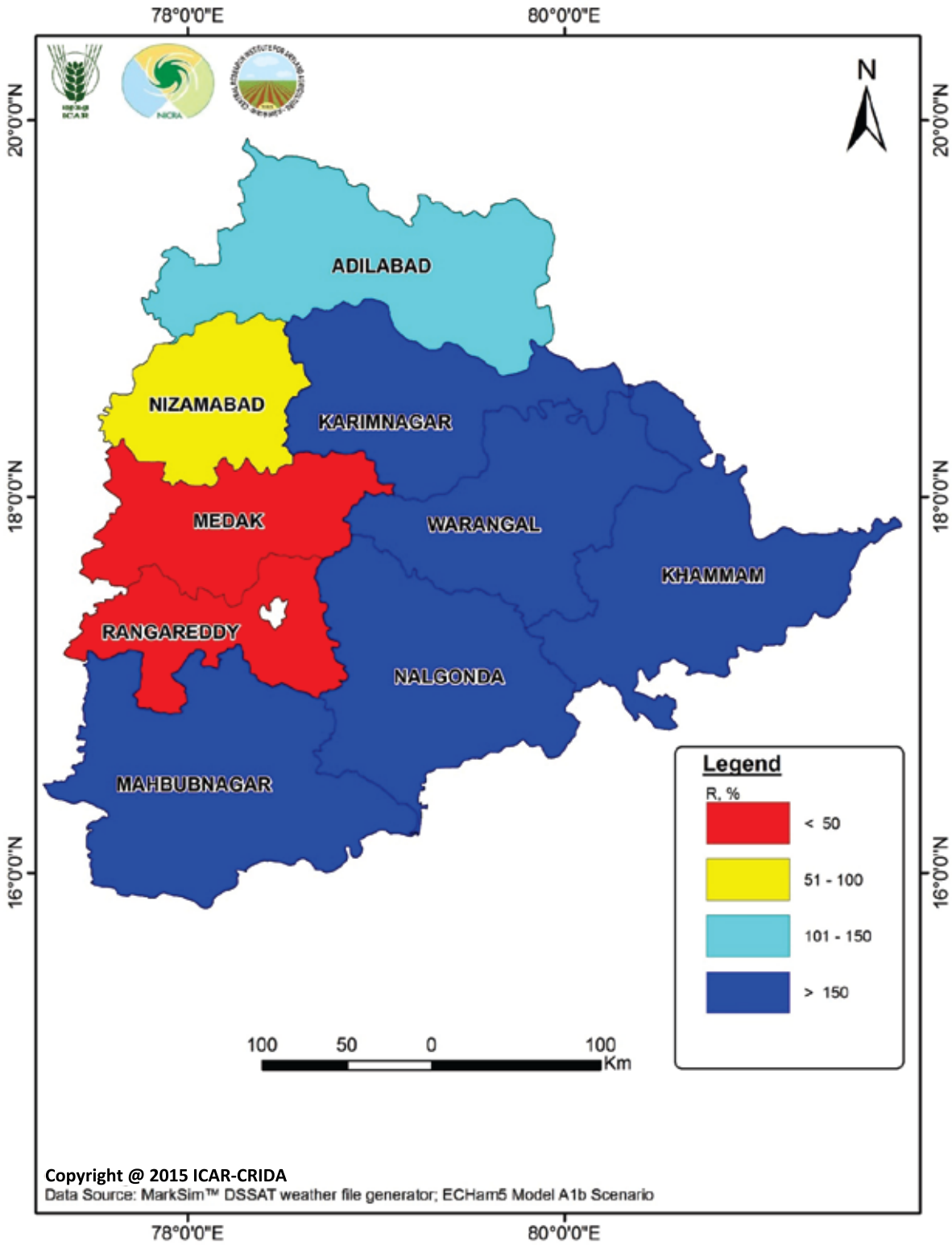

Fig.3.125 Percent decadal (2021-2030) deviation of rainfall (R) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

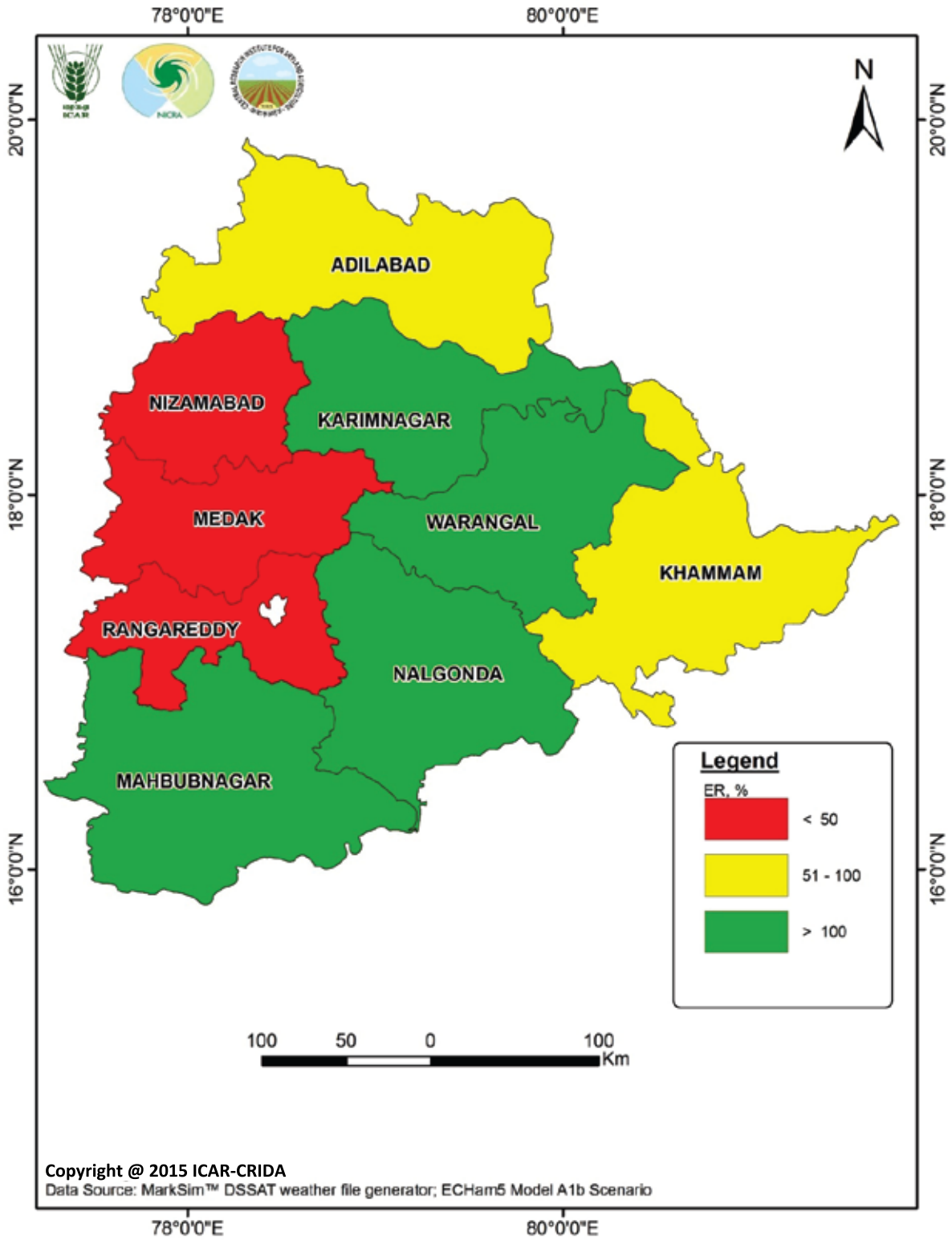

Fig.3.126 Percent decadal (2021-2030) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

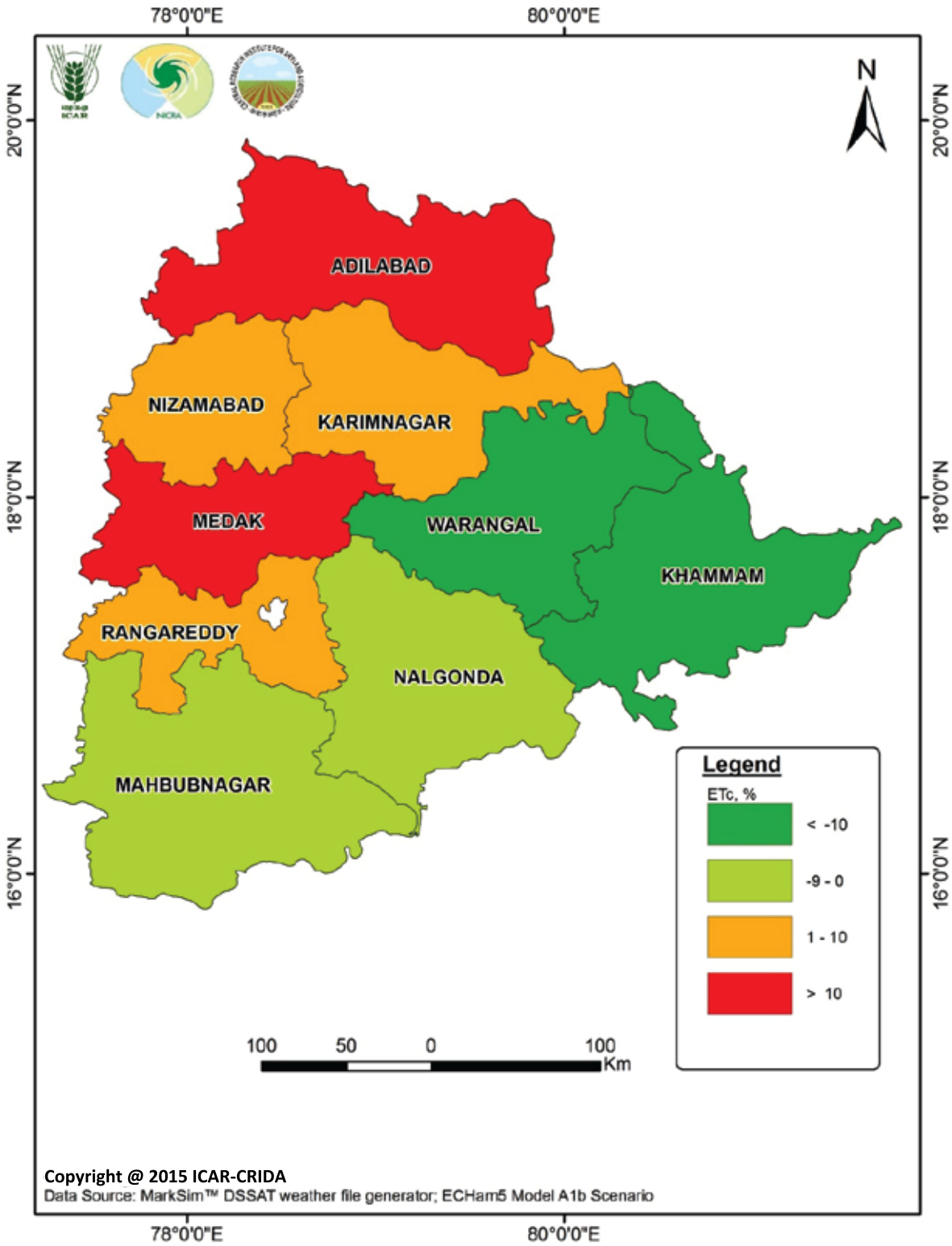

Fig.3.127 Percent decadal (2021-2030) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

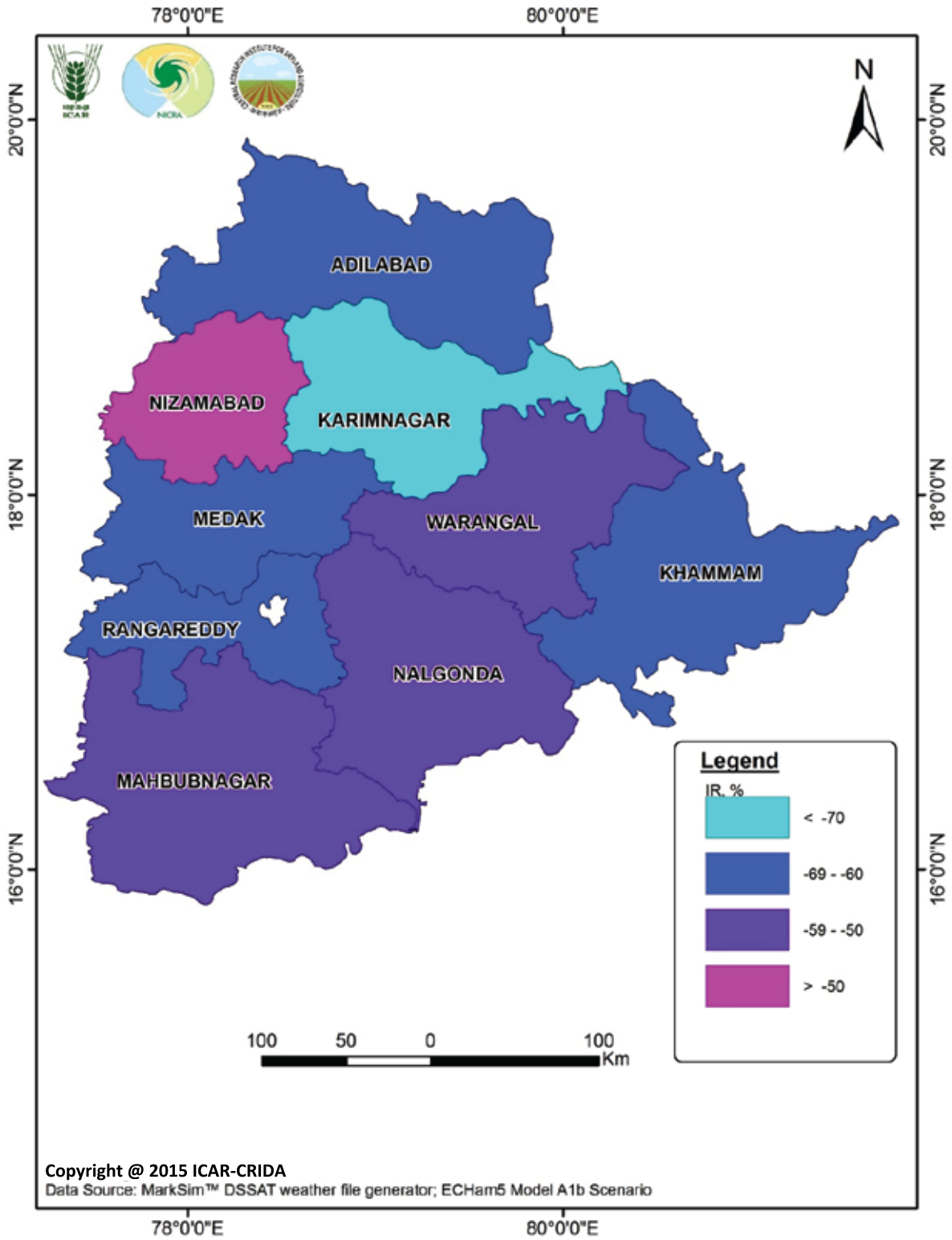

Fig.3.128 Percent decadal (2021-2030) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

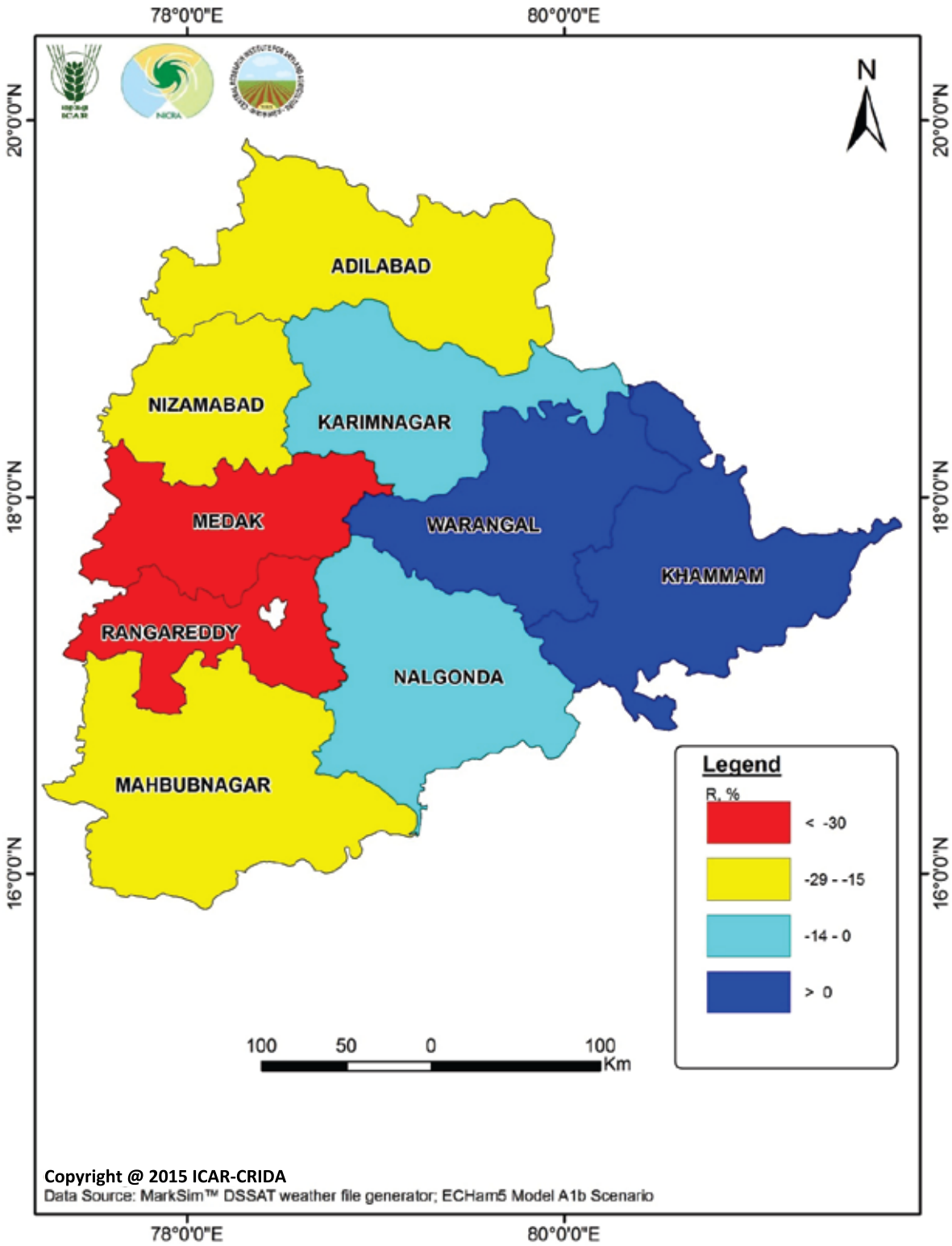

Fig.3.129 Percent decadal (2031-2040) deviation of rainfall (R) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

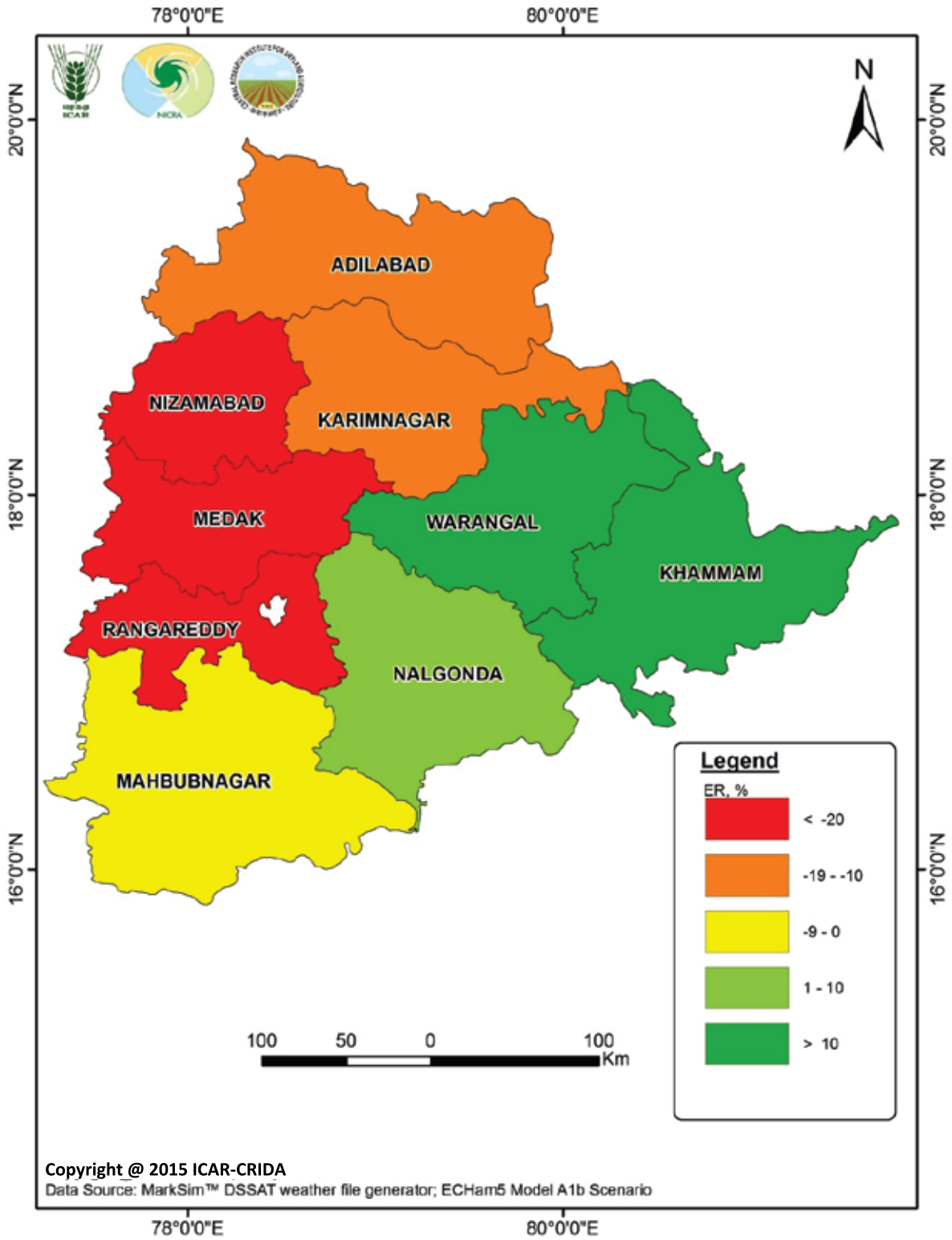

Fig.3.130 Percent decadal (2031-2040) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

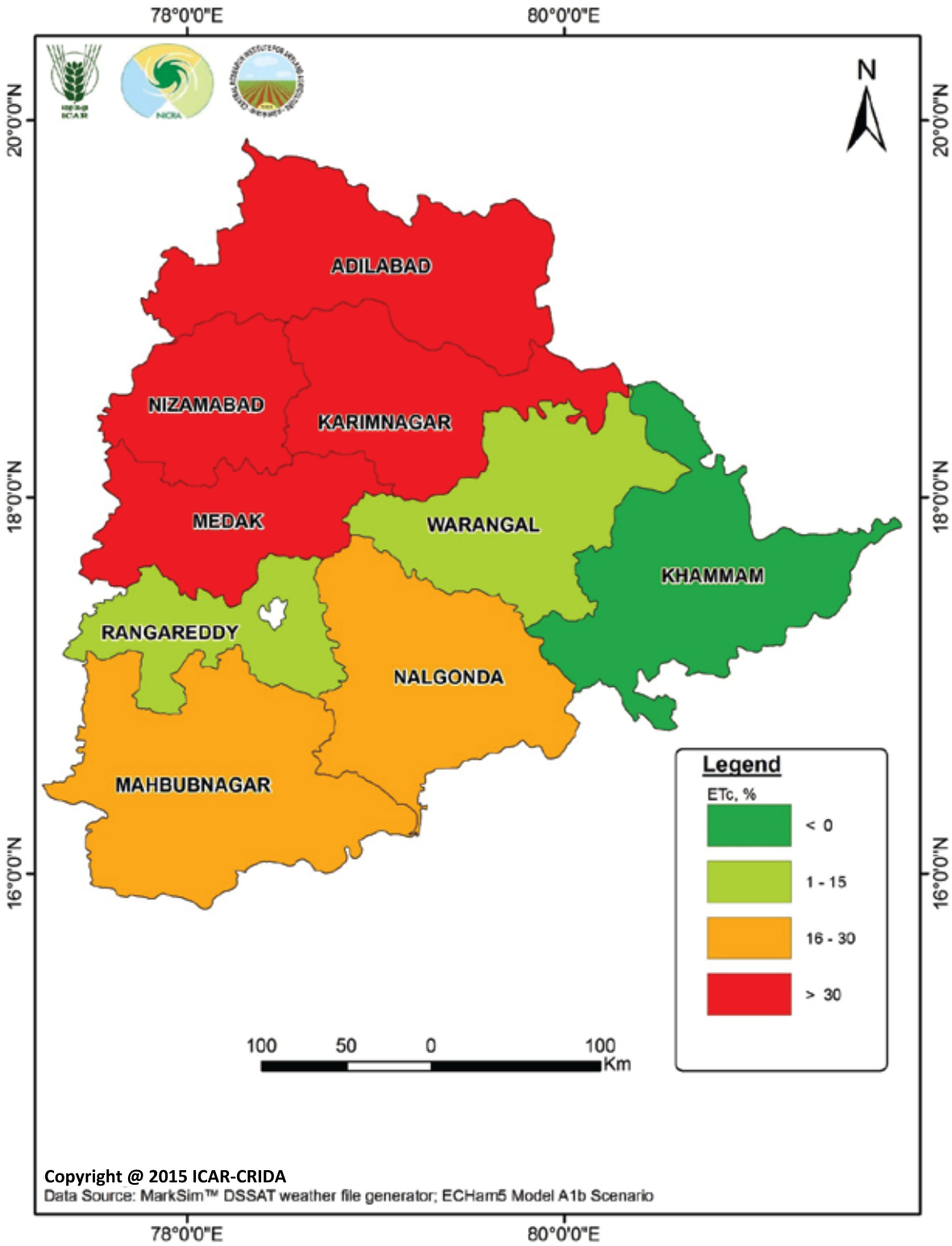

Fig.3.131 Percent decadal (2031-2040) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

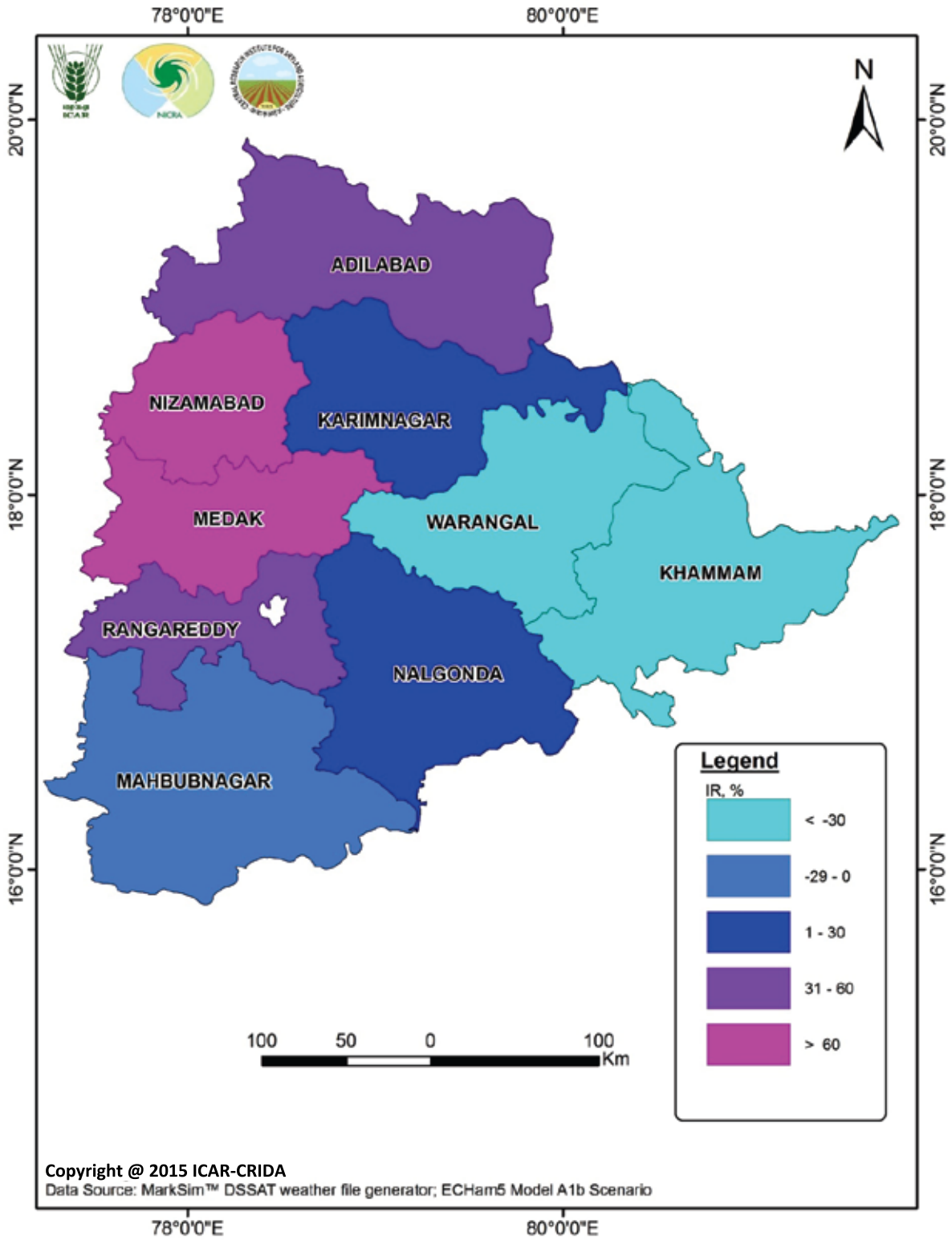

Fig.3.132 Percent decadal (2031-2040) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

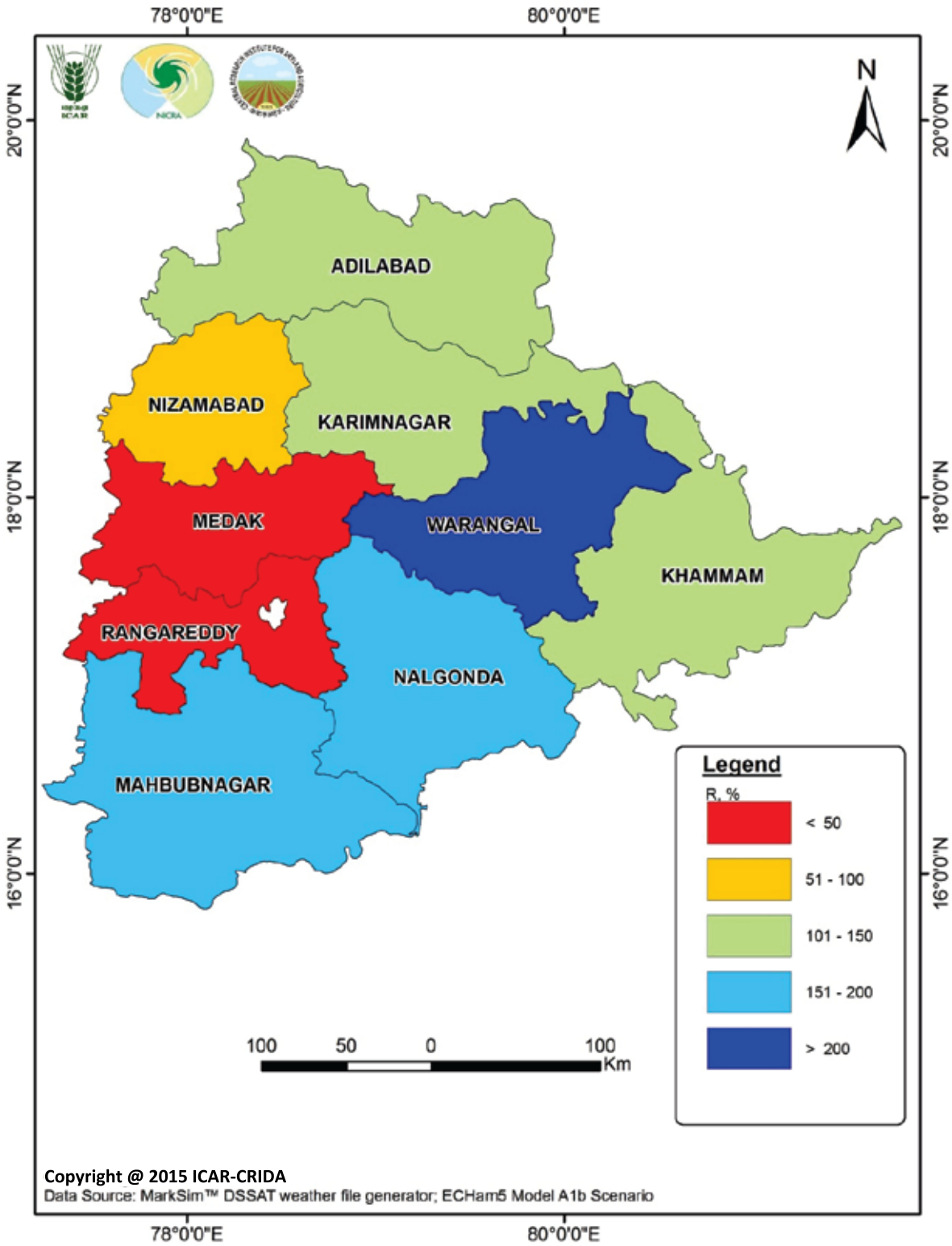

Fig.3.133 Percent decadal (2031-2040) deviation of rainfall (R) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

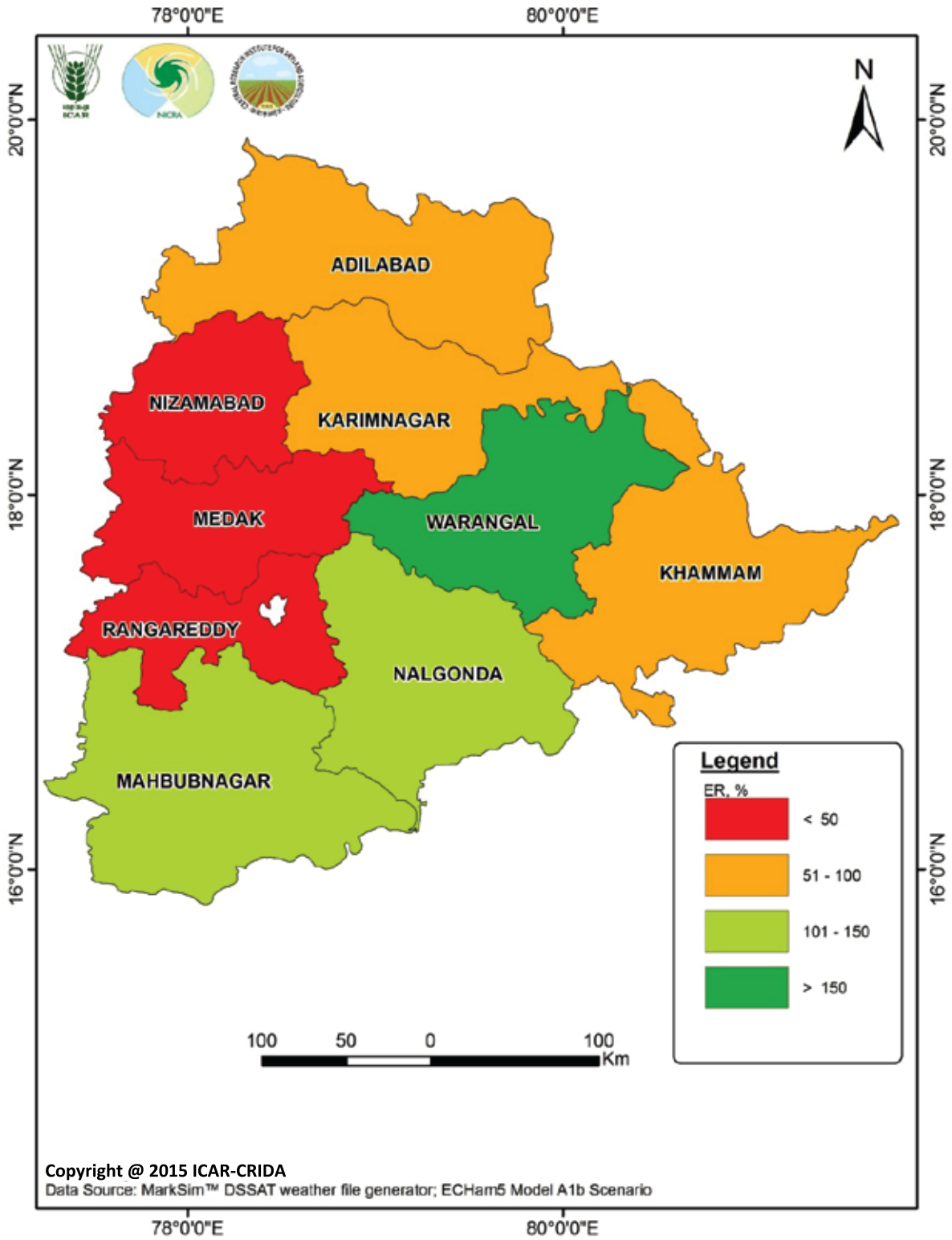

Fig.3.134 Percent decadal (2031-2040) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

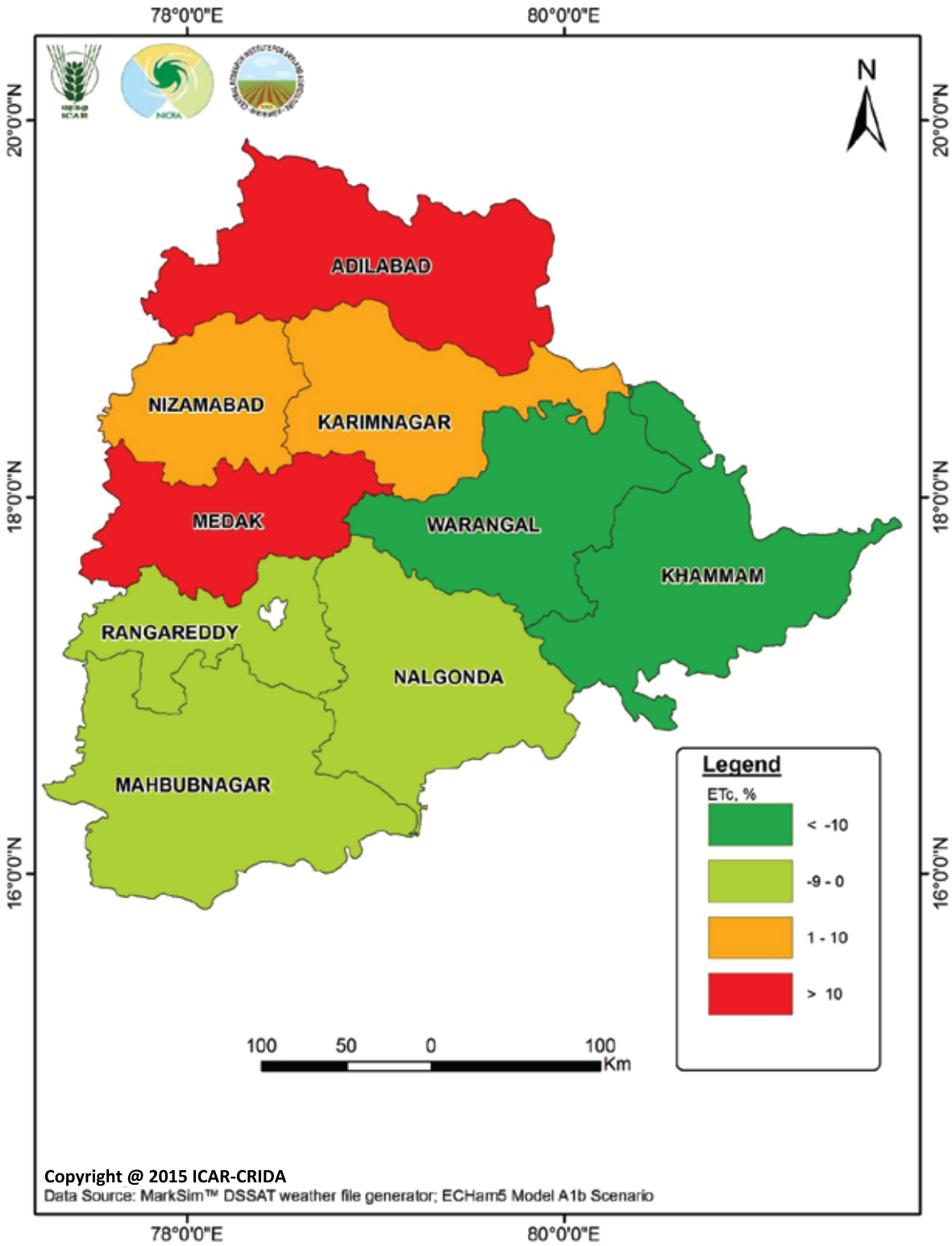

Fig.3.135 Percent decadal (2031-2040) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

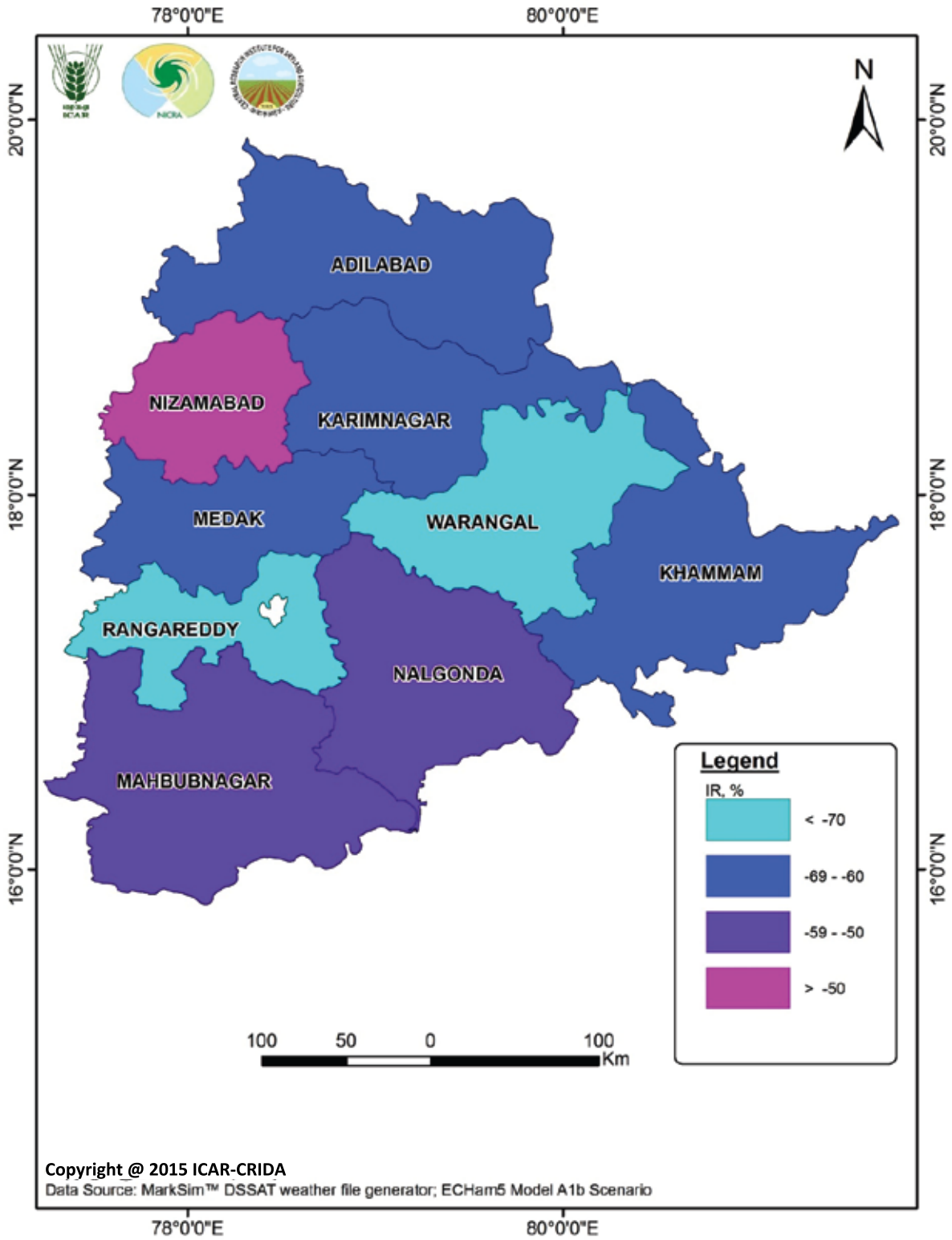

Fig.3.136 Percent decadal (2031-2040) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

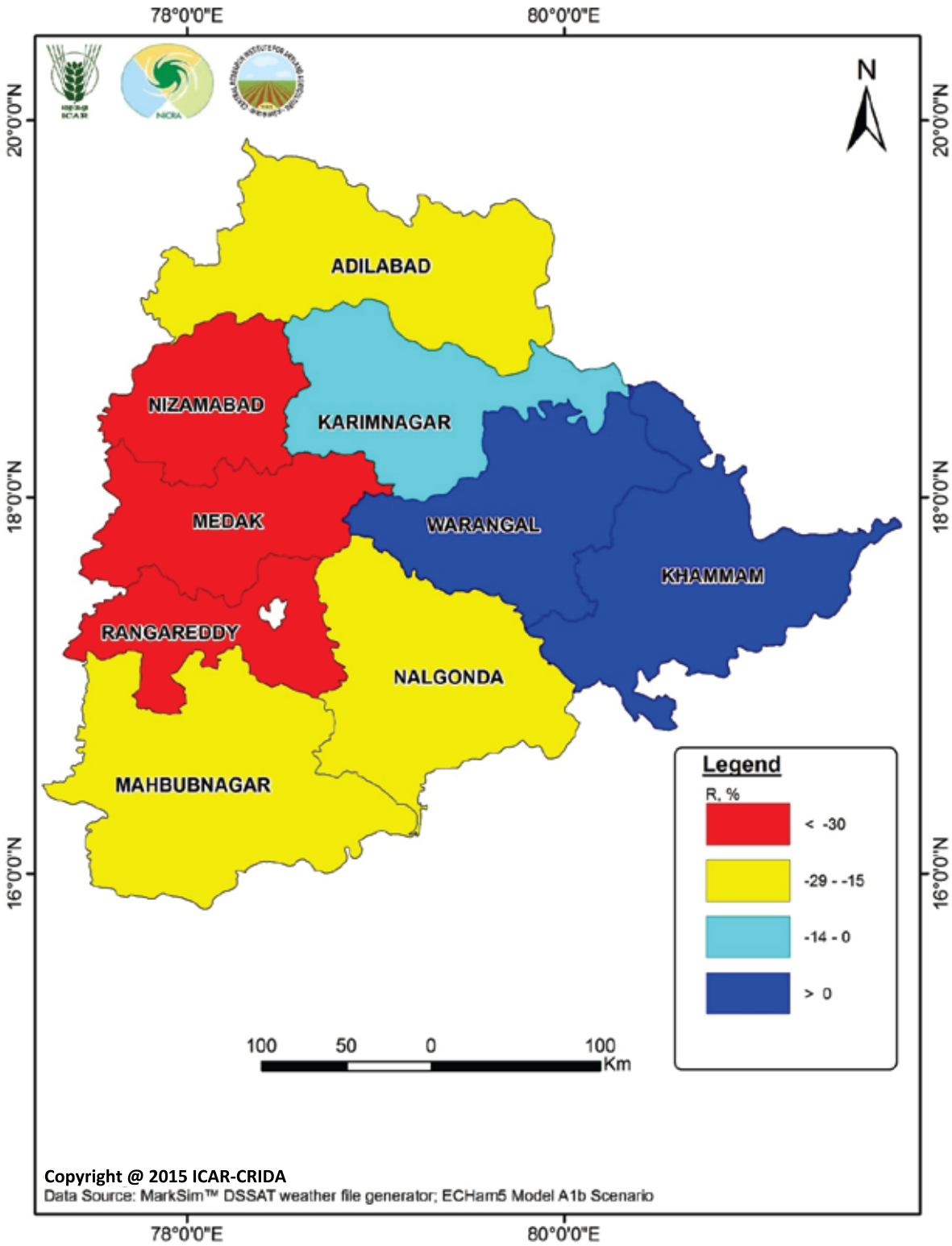

Fig.3.137 Percent decadal (2041-2050) deviation of rainfall (R) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

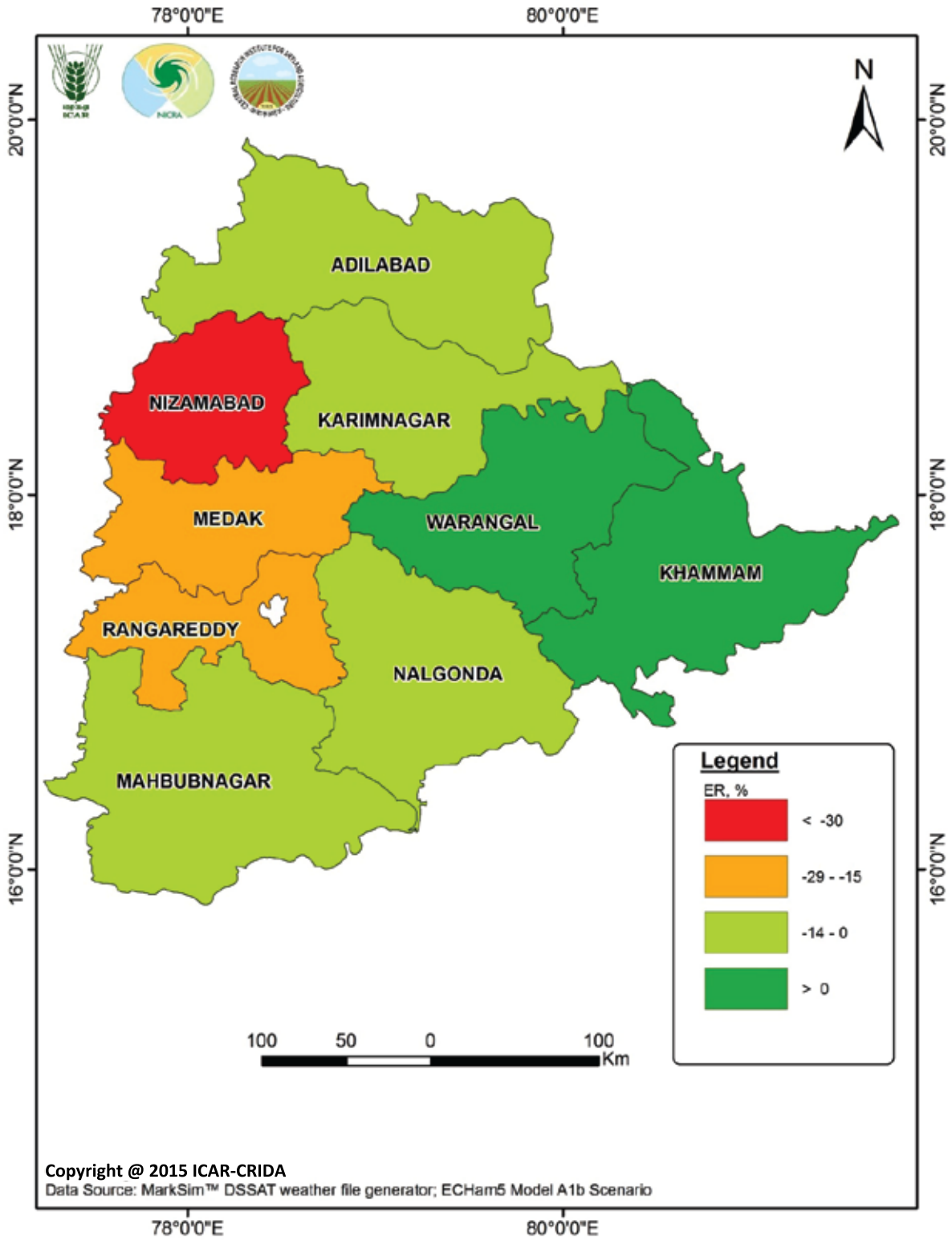

Fig.3.138 Percent decadal (2041-2050) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

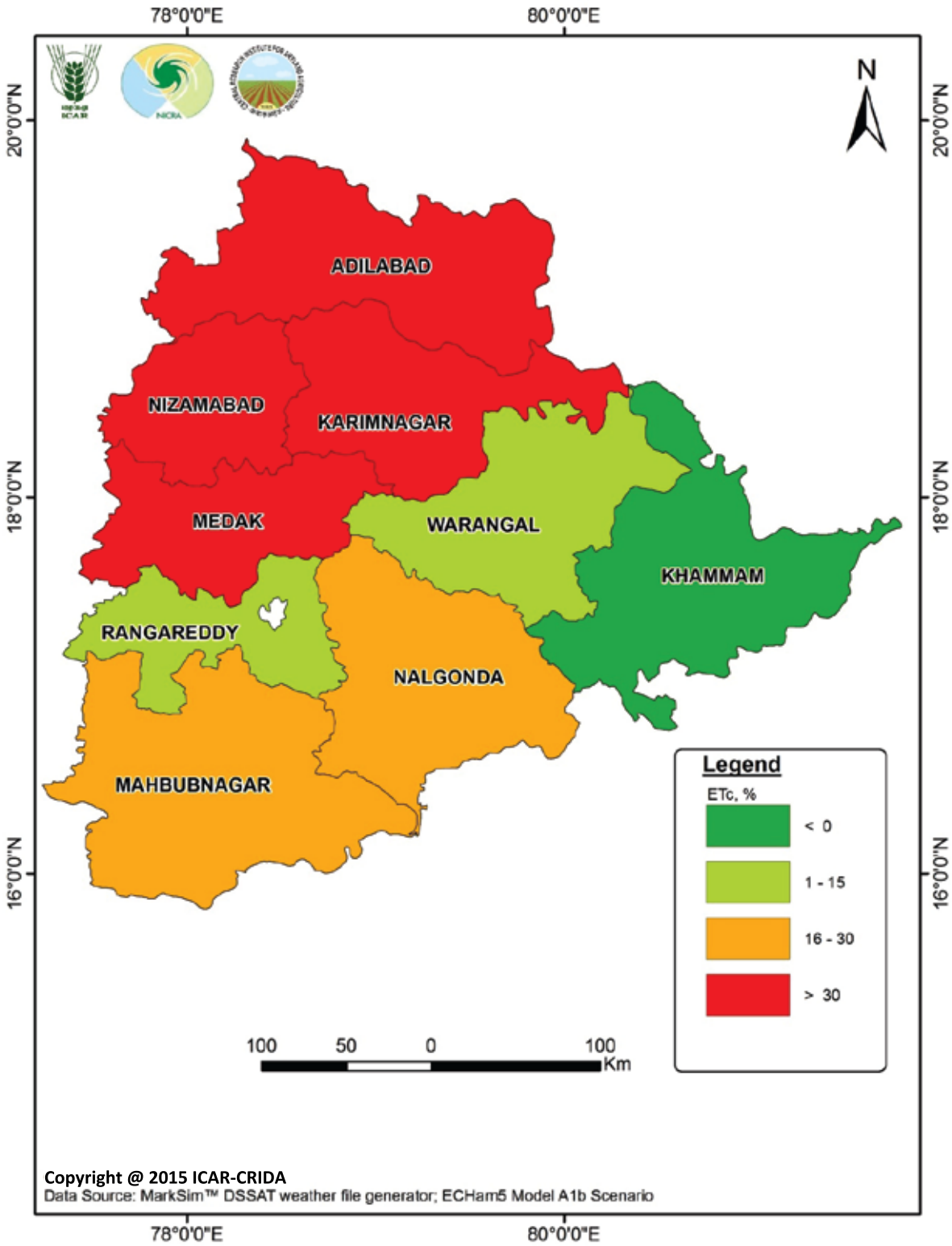

Fig.3.139 Percent decadal (2041-2050) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

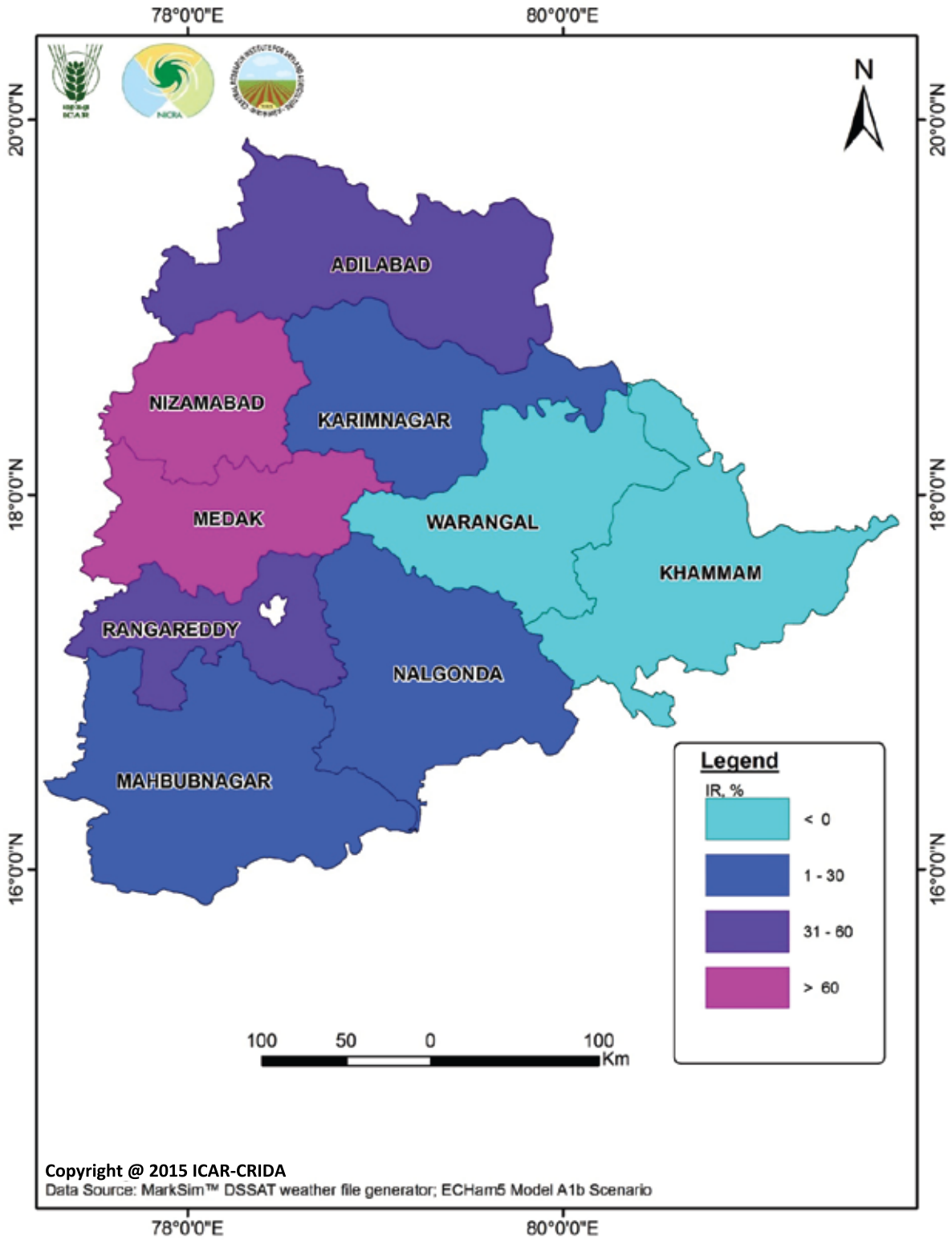

Fig.3.140 Percent decadal (2041-2050) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of maize under normal sowing in Telangana

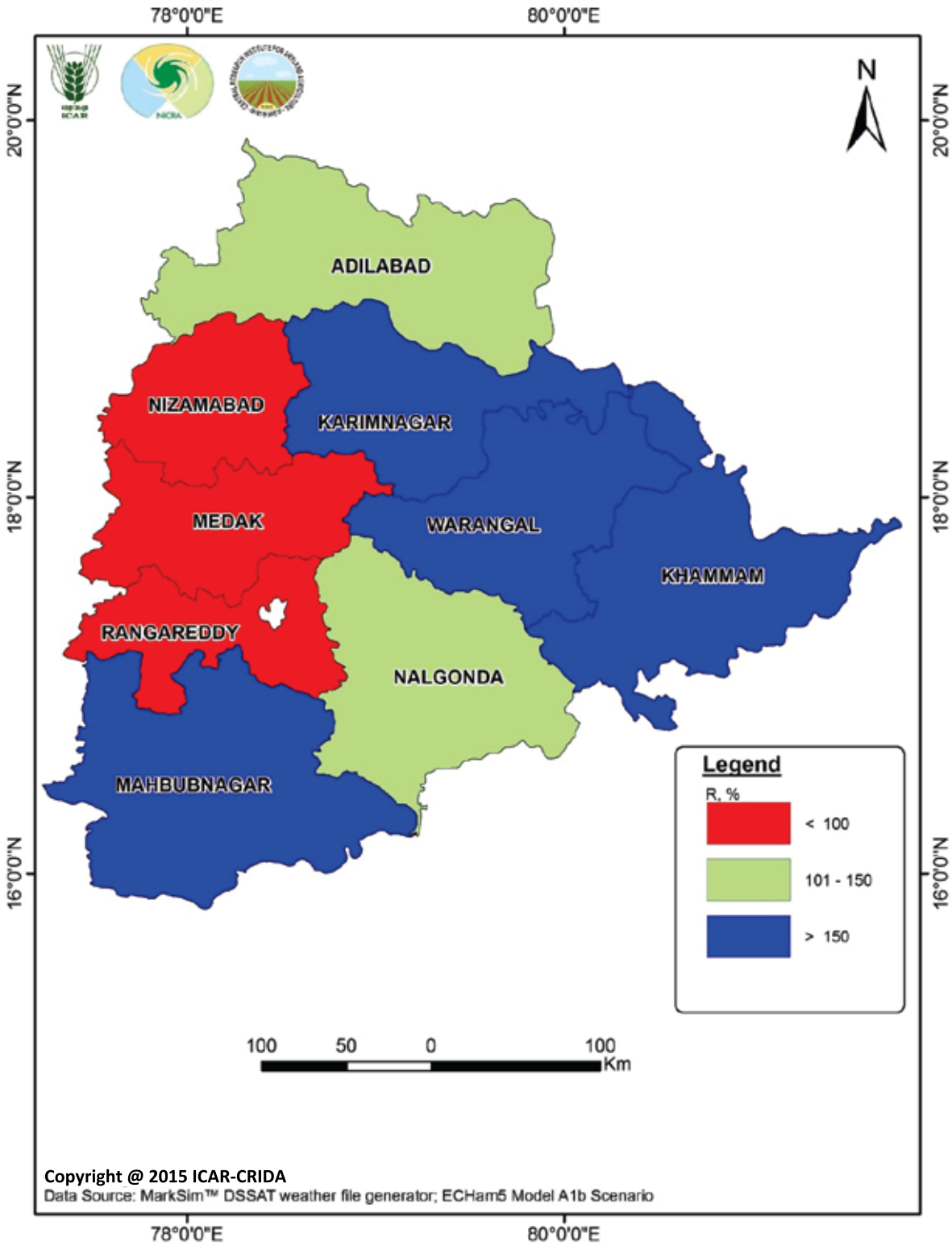

Fig.3.141 Percent decadal (2041-2050) deviation of rainfall (R) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

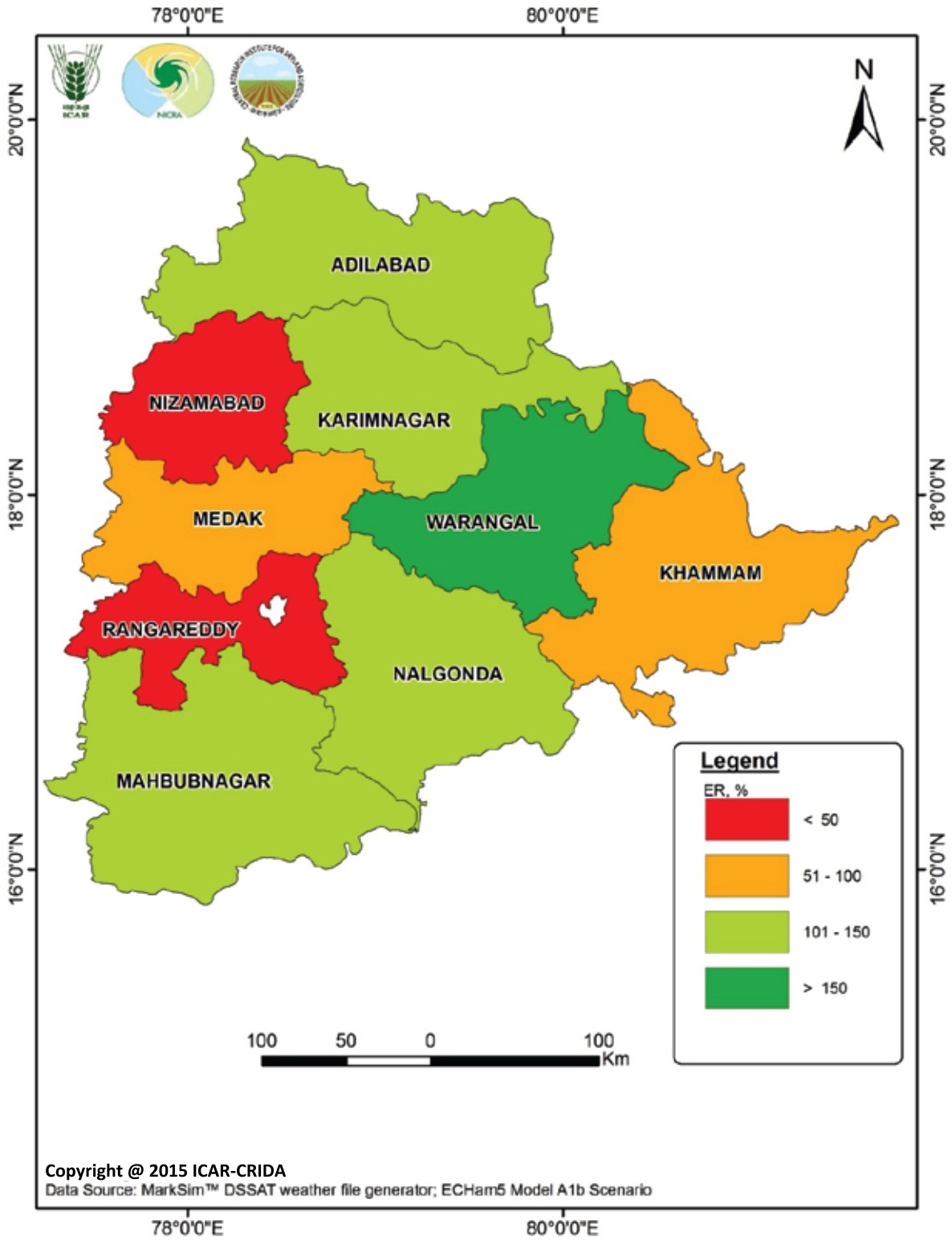

Fig.3.142 Percent decadal (2041-2050) deviation of effective rainfall (ER) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

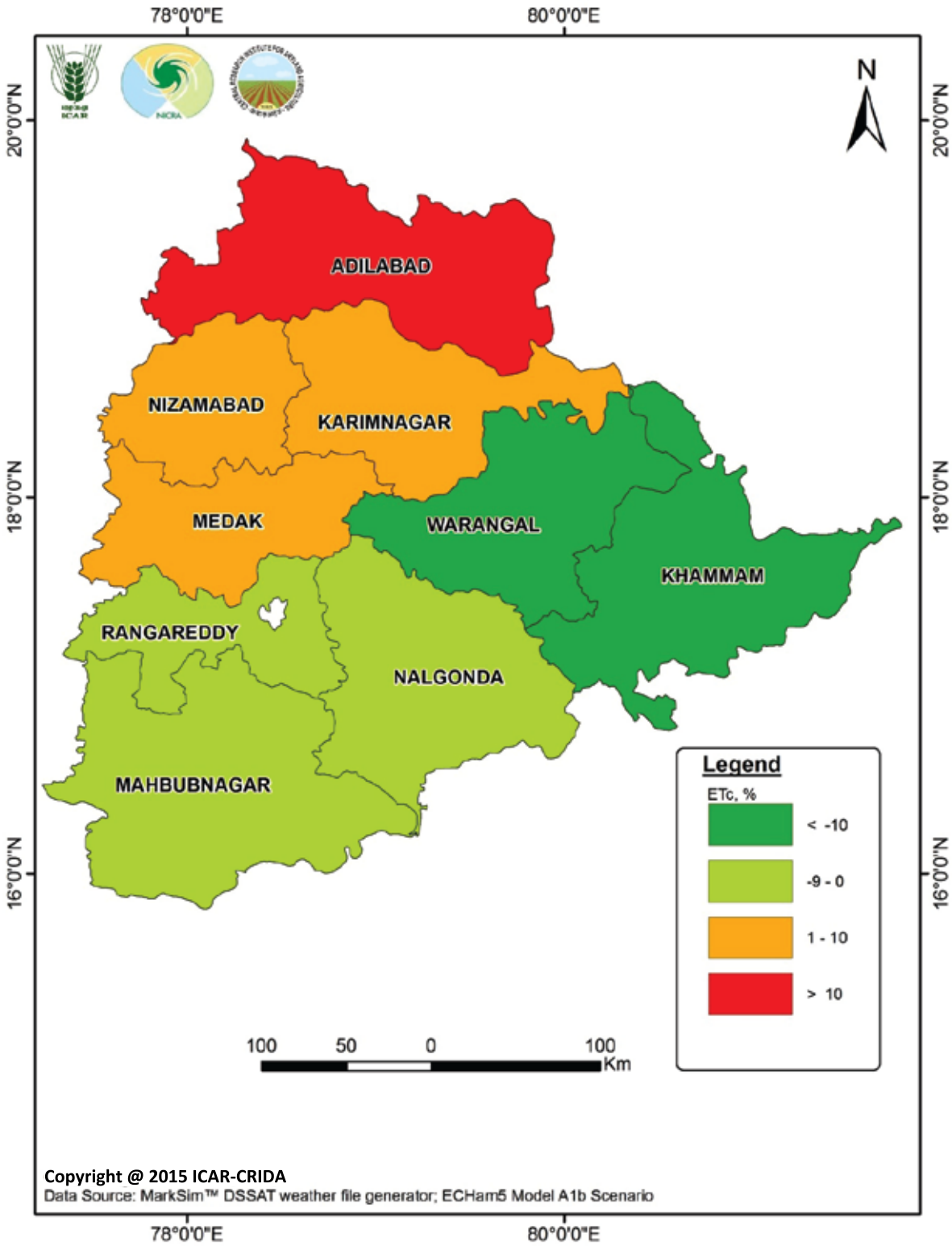

Fig.3.143 Percent decadal (2041-2050) deviation of crop evapotranspiration (ETc) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

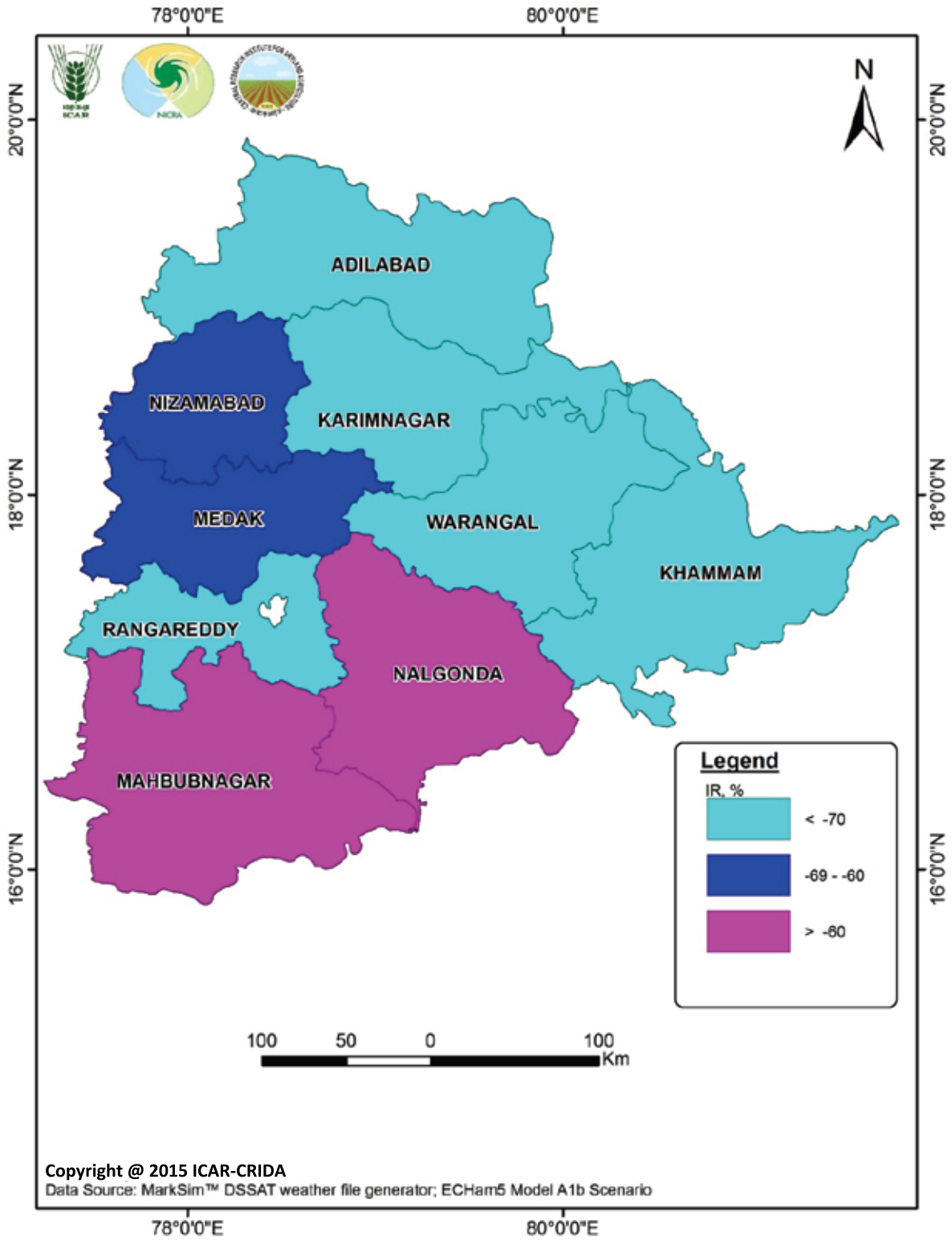

Fig.3.144 Percent decadal (2041-2050) deviation of irrigation requirement (IR) from base period (1961-1990) during crop growth period of maize under late sowing in Telangana

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