

# -RXUQDO RI 0DULQH 6FLHQFH 5HVHD 'HYHORSPHQW

%DQIDOYL - 0DULQH 6FL 5HV  
'2,

5HVHDFK DUWLFOH

20, & 6, QWH

## \* OREDO /RVV RI )UHVKZDWHU DQG 6DOLQDWLRQ

\*DVSDU %DQIDOYL

'HSDUWPHQW RI %LRWHFKQRORJ\ DQG 0LFURELRORJ\ 8QLYHUVLW\ RI 'HEUHFHQ 'HEUHFHQ +XQJDU\ &RUHVSRQGLQJ DSDUWPHQW RI %LRWHFKQRORJ\ DQG 0LFURELRORJ\ 8QLYHUVLW\ RI (0DLO JDVSDU#XQLGHE KX

5HFHLYHG 0DWH \$FFHSWHG \$DWH 3XEOLVKHG \$DWH

&RSULJKW %DQIDOYL \* 7KLV LV DQ RSHQ DFFHVV DUWLFOH GLVWULEXWHG XQGHU WKH WHUPV RI WKH GLVWULEXWLRQ DQG UHSURGXFWRQ LQ DQ\ PHGLXP SURYLGHG WKH RULJLQDO DXWKRU DQG VRXUFH D

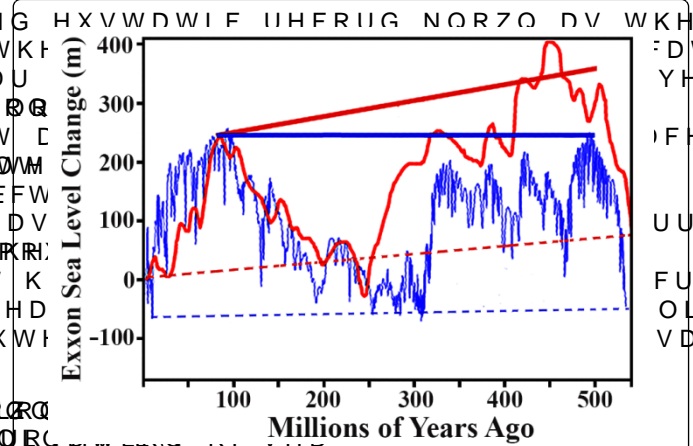
### \$EVWUDFW

7KH VHD OHYHO KDV FRQLQXRXVO\ IOXFXWDWHG RYHU JHRORJLF WLPH 7KH EH ZDV SURYLGHG E\ JHRORJLVWV ZKR VWXGLHG WKH VKLIWV RI VKRUHOLQHV DQG UDOVR UHIHUHG WR DV VHTXHQFH VWUDWLILFDWLRQ &RQLQXQLQJ JOREDO ZDUPLQ RI WKH JODFLDO LFH DQG VQRZ UHVHUYHV FRXOG UHVXOW LQ HDUOLHU KLJK VHD ZHUH WXUQH WR YROXPHWULF GDWD 7KLV ZDV DFKLHYHG E\ FDOFXODWLRQV L JHRPHWULF UDGLXV RI WKH JHRLG (DUWK LL VHOHFWLQJ DPRQJ GDWD IRU DQ DY YDOXH RI EHVW ILWWLQJ YDOXH 8SRQ UHOLDEOH GDWD ZLWKLQ GHYLDWLR EHWZHHQ WKH YROXPHV RI VHD WKDW ZRXOG EH QHHGHG WR DFKLHYH GLIHUHQV WKDW NP PHOWLQJ RI WKH DYDLODEOH IUHVK ZDWHU UHVHUYHV RI SRODU J VQRZ a NP ZRXOG FDXVH DERXW P VHD OHYHO ULVH 7KHVH FDOFXODW P VHD OHYHO HOHYDWLRQV ZLOO QHYHU EH REWDLQHG GXH WR WKH JOR FRQQHFWLRQ ZLWK WKH ZDWHU GHILFLHQ\ WKH RVPWLF JDS EHWZHHQ WKH RV 2VP DQG WKDW RI VHD 2VP LV UHIOHFWLQJ WKH VDOLQDWLRQ RI RFHQ 6D WHUP GLOXWLRQ SHULRGV DQG D ORQJ WHUP VDOLQDWLRQ SURFHVV /RQJ WHUP V DQG IUHVK ZDWHU ZLOO VHULRXVO\ LPSDFW IXWXUH OLIH RQ (DUWK

.HIZRUGVHD GHSWK 6HD YROXPH 6DOLQDWLRQ SURFHVV OLPLKEXWLRQ UHG G SHULRGV 2VPRODULW\ (VFDSH RI ZDWHU VDSR\$OWKRXX OHVV PDUNHGO\ WKDQ GHFOLQLQJ WHQGHHQ\ RI ([[RQ VHD OHY VHDZDWHU )LJXUH EOXH OLQHV

### ,QWURGXFWRQ

H EHVW NQRZQ DQG PRVW DFFHSWHG ([[RQ &XUYH DOVR UHIHUHG WR DV WKH WKDW WKH VHD OHYHO WRGD\ LV QHJU )LJXUH RVFLOODWLRQV LQ EHOXPHRQ WKH VKDSH RI RFHQDLF EDVLQV EXW E WHFWSOLFQ SURODSVHV \$V DXEHWXDOM KXQGUHG RI PHWHUVHR PRUWHGURJLEFW VKULQNDJH RI LFH VKHHWV LQ WKH ODV SULPDULO\ LQ WKH 1RUWKHUODKHELVSR RI ZDWHU FRXOG EH FRXQWHUDFWHG DW K HYDSRXUDWLRQ RI VHD \$OWKRXXK VHD V\ VWHP EDVHG RQ WKH ODZ RI GLOXW UHGXFHV HYDSRXUDWLRQ > @



,W HVFDSHG DWWHQWLRQ WKH VWXNDWLRQ FOLPDWLF FKDQJHV OHG LWRUHWKHHZSORC YROXPHWULF FDOFXODWLRQV WKDW WKH PHOWLQJ RI LFH RI JODEFHUY DQG SHUPDQHQW VQRZ FRXOG QRW HOHYDWLQJ WKH VHD WLRQV HDUOLHU KLJK OHYHO WKH IUHVKZDWHU UHVHUYHV DUH FORVH WR H\KD XVWLRQ ,W LV FRQFOXGHG WKD ORVV RI ZDWHU WR VSDFH DQG WKH UHODWHG VDOLQDWLRQ RI VHD DUH PRU WKUHDWHQLQJ OLIH RQ (DUWK WKDQ WKH UHIOHFWLQJ UHODWLYH DV VKRWWHWHU LQWHUJODFLDO GLOXWLRQ SURFHVV RI JOREDO ZDUPLQJ OXFRQWLE XQLGHE E\ [[RQV OLQH ([[RQV ORZ)JXUHDHSHWSDUHG E\ 5RKHG IURP SXEOLFO\ DYDLODEOH GDWD >

### 6HD QXPHQDWLRQV

H VHD OHYHO FKDQJHV LQ +DOODPDV XSSHUWHG FXWVHVS) LJXQH ZLNLSH@LD RUJ VKRZ WKH WHQGHHQ\ RI JUDGXDO GHFUHDVH 3KIDQRWR] WKH BOPDIBF XPHOL SXUHVKDUH

KWWS ZZZ XQLYHUVHWRGD\ FRP GLDFFHWYRORIPHDELDWKIG RIGWRVSHDQ DUHD [ D  
 ZZZ QJGF QRDD JRY PJJ JOREDO HWRSRNRFRFHDQBRYRQXNPV KWQFOYLDWLRQ EHWZHH  
 \$V IDU DV WKH HDUOLHU LPDJLQDU\ FDOFXODWLRQV LV JHRLG HOOLSRVRELG VSKHULF VKDSHV DUH  
 FRQFHUQHG WKHUH LV D JURZLQJ FRQFHUQHUVYRROXPH (DUWK REWDSURQLRURW HOK  
 VSKHULF )LJXUH 7R GHWHUPLQH LWV NFDWJXVXS% IXHYLKHULRQDVRXUHPHQODWV  
 DUH XQGHU ZD\ ORUH LPSRUWDQWO\ WKHHGHYLDQDQEQ EHWZHHMSHWVHYHWDGLL RI  
 WKH SRODU PLQLPXP NP DQG HTXDWRULDO PDILPXP NP  
 LV RQO\ a NP FORVH HQRXJK WP ORRN DW /DUWK DV D VSKHUIH IQ  
 PDQ\ FRQWH[VV KWWS ZZZ XQLYHUV HDUWK \LHEDQJUDGRUXV NP KV  
 ZZZ QJGF QRDD JRY PJJ JOREDO HWRSR

H IRUPXODH IRU DSSO\LQJ DSSUR[LPD\ DQDO\]HG E\ \$OH[DQGHU > @ (OOLSVR FRLQFLGHG ZLWK WKDW VXUIDFH WR ZI HQWLUH (DUWK WK%) EHWZHHMSUR[LPDWLRQV UDGLL )LJXUH WKH YROXPHV RI VH UHODWLYHO\ QDUURZLWVHEDWROHVHODWV VHUYHG WKHQ DV D EDVLV IRU WKH GLV WKH RFHDQ

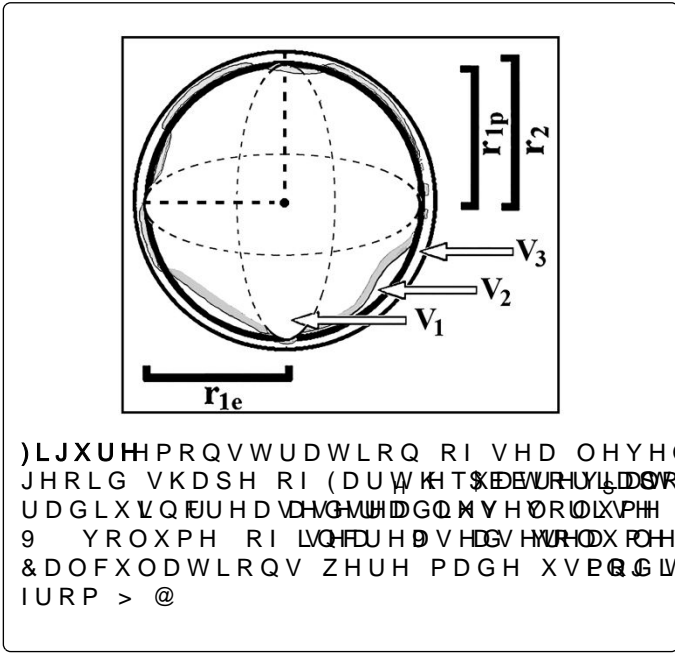
Earth radii	Radius (km)	Volume (x10 <sup>6</sup> km <sup>3</sup> )	Reference
r <sub>1o</sub>	6,335.439	1064.95	[10]
r <sub>1s</sub>	6,378.137	1086.5	[10]
r <sub>m</sub> (R <sub>⊕</sub> ) at sea level	6,371.008	1083.21	[10]
r <sub>2</sub> (R <sub>⊕</sub> ) only Earth	6,367.317	1081.37	Estimated

Depth of sea (m)	Area of sea (10 <sup>6</sup> km <sup>2</sup> )	Volume of sea (10 <sup>6</sup> km <sup>3</sup> )	Reference
3682.2	361.84	1332.4	[11]
3688		1335	[12]
3703	361.3	1338	[13]
3691		1332.9	[14]
-----			
3691.05 Average	361.57	1334.7	Estimated

Volumes of sea and freshwater	Volume x 10 <sup>6</sup> km <sup>3</sup>	Reference
Water vapor (0.25 % of atmosphere)	1.2875	Estimated
Water photolysed to O <sub>2</sub>	1.215	[15]
Present sea (total)	1,335	Table B
Freshwater (2.5% of sea)	38.14	*http (see below)
Freshwater (total: 3%)	41.202	[13]
Ice and snow (2%, land and sea)	25.540	[13]
Freshwater (land: 1%)	15.662	[13]
-----		
Water on Earth (total)	1,376.242	[13]
	1,386	Table B
	1,375.64	Estimated
Highest sea level (500 Mys)	1,455	Estimated
Infant Earth (3,800 Mys)	1,682	Estimated



)LJXUHHRPQVWUDWLRQ RI VHD OHYHO FKDQJH \*HRPHWULF UDGLXV 5 DV 5 DYHUDJH V JHRLG VKDSH RI (DUWK REWDSURQLRURW HOK UDGLXVQEUHDVHGHMHDGOMVHOROXPH RI (DUWKHRPHWULF YROXPH RI (DUWK IUR 9 YROXPH RI LQFHUHQDVHGHVHROXPHOHYHO ULVH™ NP &DOFXODWLRQV ZHUH PDGH XVEHQV% VSKHUH YROXPH IRUPXOD 9 VHD IURP 5 PLQXV 5™ NP™ 9VHD ZLWKRXXW ODQG DUHD™ NP™

5DGLL RI (DUWK % 2QO\ WKH ODWUHVWKDQW EHHQ LQFOX HVWLPDWLRQ RI DYHUDJH GHSWK RI VHD LV WKH GLVWDQFH IURP WKH (DUWK V &LHUHQVZHHQ NP YROXPHV LV DBOVLHU HQWLUH (DUWK WK%) EHWZHHMSUR[LPDWLRQV UDGLL )LJXUH WKH YROXPHV RI VH UHODWLYHO\ QDUURZLWVHEDWROHVHODWV VHUYHG WKHQ DV D EDVLV IRU WKH GLV WKH RFHDQ

KWWSV HQ ZLNLSHGLD RUJ ZLNL SDVWVHEDWROHVHODWV VHUYHG WKHQ DV D EDVLV IRU WKH GLV WKH RFHDQ }OH SKDQHURJRLFBVHDBOHYHO SQJ YROXPHV 7R DVVXGHVWUOBOSW RDFKHV JLYH WKH VDPH UHVXOWV IRU WKH NP™ NP™ YROXPH RI WKH VHD WZR HVWLPDWLRQV DQG WKH PHDQ YROXPH NP™ NP™ YROXPH REWDLQH E\ RWKHUV KDYH EHHQ FRPSDUHG KWWS ZDWHU XVJV JRY HGX HDUWKKRZP \*HRPHWULF DSSURDFK WR VHD YROXPH ZLWKRXXW ODQG DUHD™ NP™

(VWLPDWLRQV 0HDQ 2ZQ &DOFXODWHV ODWLRQV RI 5RVLQJdV WHDP >

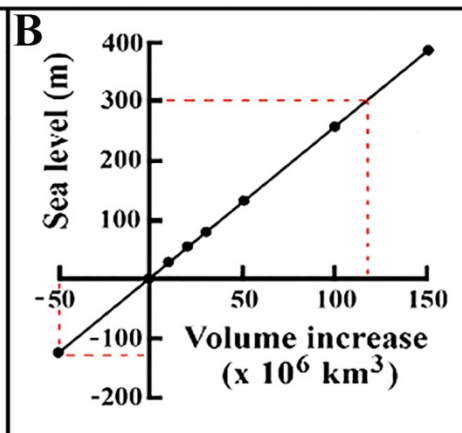
&RQYHUVLRQ RI VHD OHYHOV WR VHD OHYHOV EHORJLQJ WR WKH ODWLRQV

H FRPSDULVRQ RI IUHVKZDWHU FWHVH ZLWK UHDO ZLWUHQH [WHQG HG QRW V

H WRWDO IUHVK ZDWHU UHSUHVHQWLQJ WKH IUHVK ZDWHU UHDO ZLWUHQH

H UHFHQW HVWLPDWHV RNPORZHV DQG KLJKHVW NP™> @ YROXPHV RI RFHDQ VKRZ D

A	a	b	c	d
Radius (m)	Volume (x10 <sup>12</sup> km <sup>3</sup> )	Volume increase (x10 <sup>6</sup> km <sup>3</sup> )	Sea level rise (m)	
6,371,008	1.08321	0	0	
- 100	1.08315	- 50	-130	
+ 20	1.08322	+10	26	
+ 40	1.08323	+20	52	
+ 60	1.08324	+30	78	
+ 100	1.08326	+50	130	
+ 200	1.08331	+100	260	
+ 210	1.08332	+120	300	
+ 300	1.08336	+150	390	



)LJXUH IUHVKZDWHU UHVHUYHV QHHGHG IRU K\SRWKHWLFDO VHD OHYHO HOHYDWLRQ

6KULQNDJH RI IUHVK ZDWHU UHVHUYHV YRXLPLQJ D |& LQFUHDVH LQ GHHS VHD W

9ROXPHV RI VHD DQG IUHVKZDWHU DUH JLYHQ LQ )LJXUH & % WKH HQG RI

ORVV RI RXU IUHVKZDWHU UHVHUYR (FRUQGLQJ WR 6KLNORPHQ DEWHQ

GLVUHJDUGLQJ WKH QHJOLJDEOH WKHUHQFH D\SDVLRQ RI VHD ZDWHU UHVHUYHV

\$V IDU DV WKHUPDO H[SDQVLRQ LV FRQFHUQHG ZDWHU H[SDQGV

ZLWK D UDGLXV RI PRGXUWVHU VRVNDLQDWRU VVWKLW RVPRWLF SDUDGR[RQ  
 YDULDELOLW\ EULQJ XV FORVHU WR WKHSRSHHG IRJGODKDMU VFDH YLQQLGLVWLRQ WR  
 FDXVH HLWKHU OHVV WKDQ P WR YPOXH @RQJ GHFHGHG HHPDWLKYHQ\ ODWH  
 P FHQXU\ VHD OHYHO ULVHH>U@DVRQWZKHRRHQGVROW GHSRVLWLRQ ZDV WKH KLJ  
 VFLHQWLWV KDYH DOPRV GRXEOHG WWRWDDEHQJODERXWZKLVOMSRBOWHVLQSRVLRQ  
 WR WKH KLJKHU WKDQ H[SHFWHG OHYHOEQUZHQRQRW PRVHHRWV@BQ SLOX  
 REVHUYDWLRQV UHJXODUO\ H[FHHGHG WKHROHYDHOVXPLVGLQRMLHFWLWLRQOV KWJKH OR  
 SUHGLFWLRQ SURSRVHG WKDW WKH RFRFRQDGDMLVRQ WRR @BBDQ\ DQGEW WKHGHV  
 RI WKH FHOVWODWLYHO\ IDVW PHOWLQJ RRRSSOHU ULVHFWRRORRQR DRXVH \$HDV WLPH  
 WR ULVH PRUH WKDQ PHWHUV E\ ZR@GSQRDQHU aSHVZLPLFVRQLFHQRUHFVWRVQ I  
 SUHGLFWHG DQ HYHQ IDVWHU DQG D FRPHOZHHQPHOM IRQJPRODEHJWKRHWMDW@BQ @  
 OHDG WR D VHD OHYHO ULVH RI DERXWRPKHWRVHDDQGLQXWLRQVDSKSHUDDQRH I  
 JODFLHUV E\ > @ UXOHG RXW GUDVWLF FKDJHV LQ WKH FR  
 ODVW 0V > @ \$OWHUQDWLYHO\ WKH

%DODQFH RI 6DOLQDWLRQ DQG 'LQWLRQ SURFHVH DQG FKORULQH ZH  
 \$PRQJ WKH UHVRQV RI ORQJ WHUP > @VDQDQXSRVLRQQRVWKHDOVWKHWHUPVD  
 IROORZLQJ SURFHVHV KDYH EHHQ PHQWLRQH L LFH IRUPDWLRQ LL  
 FRQWLGHQMLD ZHDWKHULQJ DQG GHQXGDLRQ RYDQURQDSLRQ WR 2XWH  
 FFOH Y VHD OHYHO UHJUHVVLRQ YL ULYHU SROOXWLRQ DQG RFHQDQ GXP SLQJ  
 FRQWDPLQDWHG ZDVWHV YLL GLVUXSWLRQ WRRWKHRRKIDGHVHSHLURFXORDDVLRQH P  
 ORQJ WHUP VDOLQDWLRQ DQG WHPSRUVRVHFRQLQXWGRZLWRRWKVHNTKIDVWEDVW  
 UHFHQWO\ UHYLHZHG > @ SODQHW 5HOHYDQW H[DPHVR RI VHTXHV  
 ZDWHU YDSRXU WR UDLO LFH DQG YORZ  
 GLRILGH SWR WKH SODQVYFRBDO RUHWRRW  
 FRQVLGHU WKH JUDGXDO ORVVRGRZDWFRQWLRQORZVHROHFVXODU ZHLJKW UHG>  
 FRFHUQ WKH HVWLPDORHG RALGOLQDGLRZVSHHFWLWLRQV PHWKRQDQ DQG WKH D  
 GLVDSSHUV JOREDO\ HYHU\ GD\ EXW UHVRXUWHVWVWKLQJ DPROJ RVKHUV WK  
 YLUWXDOO\ WKH VDPH TXDQWLW\ KWWVYUZZZHHJXDSKHLUDQFRVYXVWDFQDFEOW  
 EXVLQHV PDU ZDWHU ORVV HLJKW WKLQJVRXVHHG WR ORV > @ LV DQ HV  
 DERXW DQ LQYLVEOH JOREDO SUREOH DQG JV KHOLXP > @ ORVW RI WKH ZDW  
 DV ZDWHU YDSRXU WKDW GXH WR LWV ORZ

6DOLQDWLRQ DQG GLOXWLRQ SURFHVH VHDVXUJHWVWLRQVLFH DQG YORZ  
 RXWZHLJKV WKH LPSDFW RI WKH GLOXWLRQ SURFHVH SODQVYFRBDO RUHWRRW  
 FRQVLGHU WKH JUDGXDO ORVVRGRZDWFRQWLRQORZVHROHFVXODU ZHLJKW UHG>  
 FRFHUQ WKH HVWLPDORHG RALGOLQDGLRZVSHHFWLWLRQV PHWKRQDQ DQG WKH D  
 GLVDSSHUV JOREDO\ HYHU\ GD\ EXW UHVRXUWHVWVWKLQJ DPROJ RVKHUV WK  
 YLUWXDOO\ WKH VDPH TXDQWLW\ KWWVYUZZZHHJXDSKHLUDQFRVYXVWDFQDFEOW  
 EXVLQHV PDU ZDWHU ORVV HLJKW WKLQJVRXVHHG WR ORV > @ LV DQ HV  
 DERXW DQ LQYLVEOH JOREDO SUREOH DQG JV KHOLXP > @ ORVW RI WKH ZDW  
 DV ZDWHU YDSRXU WKDW GXH WR LWV ORZ

H UHDO ORVV UHIHUV WR WKH ZDWHU WHEVXONH UHVRORHFRZOHGRIDHEDVPRVHV  
 VKULQNDJH RI YROXPHV RI RFHQDQ DQG DWHPRVSRVHU FRQWLDXWHLQEQ WKH DWP  
 PROHEXOHV RI WKH ZDWHU YDSRXU JDY  
 R\JHQ DQG KHGURVVRXUFH RI R\JHQ DQGLYRKRWRVWVWKLQJ DPROJ RVKHUV WK  
 ODQG NY\ DQG RFHQDQJ\ >™ @ 0RQVXODU DWRPV RI ZDWHU RULJLQ EHLQ  
 R\JHQ LV GLVVROYHG LQ ZDWHU VHD DQGLYRKRWRVWVWKLQJ DPROJ RVKHUV WK  
 DWPRVSKHUH DWRPV PD FRPELQH DQGLYRKRWRVWVWKLQJ DPROJ RVKHUV WK  
 H WKLQ RJRQ OD\HU VKLHOG SURWHFWV  
 SUUDWLRQD FROVLVV UHEV &FOH  
 HOHFWRQ WUDQVSRUW FKDLQ QXWULHQWV DUH RILGLHG DQG FROYHUWHG WR IR  
 DQG XVHIXO HQHUJ\ LQ FHOOV H ORV RI ZDWHU ZDV VWXGLHG DV IR  
 PLVVLRQ RSWLPLVHG WR WKH DWPRVSKH

2FHDQV ZLWK KLJKHU VDOW FRQWHQVSDUWVSDVHDOVWHU SURVVRQVRIOMVH(XU  
 R\JHQ JHQHUDWH ORZHU YDSRXU SUHVMXN DSSURFHOVGLRQQLWUWKHGDLQRXQW  
 RI IUHVK ZDWHU VORZ GRZQ WKH KIGURKORVSDQZZQGV DODQVWDXBBSFM LYLWLHV 6S  
 \$Q HVWLPDWHG PHOWEQJ @IRWK 9HQXVB([SUHVVBJRHBVJHQWO\BLQWRBWKH  
 NP> @ LFH DQG SHUPDQHQW VQRZ UHVHISUHVPMRU GLVFRYHU RI WKH 9HQXV  
 RI a P +LJKHU VHD OHYHO ULVHV LQDWRKQUPHGH ORVV RI D ODUWHGTXDQWLW  
 SURYH WKLQVSDQWLRQ RI WKH IUHVKZDWHU RULJLQDQGLYRKRWRVWVWKLQJ DPROJ RVKHUV WK  
 ORVW DQG HYDSRXUDWHG WR VSDFH FRQWLRQVWKLQJ DPROJ RVKHUV WK  
 GHQVH WKDQ WRDWRI 9HQXV DW WKH VX

2FHDQ DV D 6HPLFORVHG 2VPROVH6VWHP  
 H 'HYRQLDQ VDOW FRQFHQWUDWLRQ UHFRQDQGLYRKRWRVWVWKLQJ DPROJ RVKHUV WK  
 FRUUVSRQGHG WR WKH FRQFHQWUDWLRQ RRV@RQVHOHFWRQVWVWKLQJ DPROJ RVKHUV WK  
 WKH WLPH ZKHQ OOHVGHVHWHBUDVWVWKLQJ DPROJ RVKHUV WK  
 RVPRODOLW\ RI WRGD\DV VHD 2VP &RQFRQVLRQ WKUHH WLPHV KLJKHU  
 WKDQ WKH EORRG RI ODQG YHUWHEUDWHV 6ROLG HYLGHQFH LV SURYLGHG WKDW Z  
 (YLGHQFH LV EDVHG RQ WKH IDFW WKDW V

LV XQDEOH WR HOHYDWH VHD WR HDUOLH X UHOLJK FOWR H30V DHR JHQV HHRJYR HURR HDUOH W  
H[KDXVWLRQ &KURQRORJ\ RI WKH \*HRORJLFDQ 5HFRUG %

)UHVK ZDWHU LV ORVW DV ZDWHU YDSR )LOOLRQ W HDUVRXV HUH V D FHO >FKB QJH (IFR  
DVVXPHG WR FRQWULEXWH WR WKH VDOLQDWLRQ RORVOD (DUWK 0LQHU 6FL S

6DOLQDWLRQ RI VHD LV UHODWHG WR WKH PHOWLQJ H OXPHU FV RI FRPSXWH O H R F I S R  
LFH DQG VQRZ 'LOXWLRQ RI VHD LV UHJDUGHG D WHPSRU DU\ HSLV RGH  
EHORQLQJ WR WKH RQJRLQJ LQWHUJODFLDO SHULRG VSHHG HG XS E\ UHFHQW  
JOREDO ZDUPLQJ XSGDWHG

)DVWHU PHOWLQJ RI LFH DQG VQRZ FDX VFDU KRJJKS\ ORFDO GLOXWLRQ VWRUP  
LQWHQVLDQ WLRQ DVNLQJ WKH ORQJ WHUP (DORFDO :VDOLQDWLRQ RI WR OXPHV RI W

(DUWK LV QRW D VHD OHG RQO\ D fVHPL FODVH G JOREDO FRYORV D W L W V W H P  
WXUQH G IURP D GLOXWH 'HYRQLDQ VROXV V R J U D X P WR DQ RVPRO\WH  
EHWZHHQ GLOXWH DQG FRQFHQWUDWHG 6KLRORPDQR\ \$ 6RNRORY \$\$ 0HWKRGR

2QJRLQJ ORQJ WHUP VDOLQDWLRQ LQFUHDVH V DOW ERORFH QW D W L R O R I V H P  
JHQHUDWHV ORZHU YDSRXU SUHVXUH FORXG DQG SHULSLWDWH TRUPDWLRQ D  
FDXVHV WKH VSUHDG RI GHVHUWV +RGUR 6FL 3XEUF

H ORVV RI IUHVK ZDWHU WKH IDOOLQJ \$ D B W H R O H S H F D V X F O R V Z D W H O J Y D S R X U D  
DLU HQGDQJHU WHUHVWULDO OLIH DQG \*HUPDQ J H X D O O\ UHVWULF OLIH WR  
RVPRWROHUDQW VSHFLHV LQ DQ LQFUHDV BSH\ & DOWG D Q G L Q V R X S V R W R H F

)LQDOO\ XQOHVV JOREDO SDUWLFXODU G R V L U J H Y K % Z D W H W \$ B O O X W L R Q M Z L O X P E  
OLPLWHG WKH VDOLQDWLRQ SURFHVV FRQWULEXWH G D E Q W P D Q U Z L V Q Q E H D W F H H O H U D  
6DOLQDWLRQ LV UHJDUGHG D PRUH GHYD V H D W H L O R X U R F H V V W R S O H I H R S W L D D W O \ V  
WKH UHFHQW JOREDO V D W L R Q W H S U V R G H G 6 F V H Q D W W R I D  
QDWXUDOO\ RFFXUULQJ LQWHUJODFLDO G 6 O X W R P O Q S R V S H V V :RUOG IUHVK ZDWHU U

&RPSHWLQJ ,QWHUHVW

H DXWKRU GHFODUHV WR KDYH QR FRPSHWLQJ LQWHUHVW

\$FNQRZOHGJHPHQW

LVZRUN ZDV VXSSRUWHG E\ WKH 27.\$ JUDQW UH VHD W R Y H Q\ U L V H 1D W X U H  
3RRU 5] :LOOLDPV 56-5 7UDFH\ & VHD  
VXUYD\ IDFW VKHHW S

5HIHUHQFH

9DLO 35 0LWFR R R S V R Q , 6HLVPLF VWUDWLV D Q S K Y D Q G V V /DZUHQFH  
JOREDO FKDQJHV RI VHD OYHO 3DUW \*ORFDO W L F O H V R V\ W H R P W L S H W W K O H Q J % V R Z Q V H D G  
OYHO 6HFWRQ \$\$ S S L F B W L R Q X R D M S H L O S L F  
VWUDWLVJUDSKLF LQWHUSUHWDWLRQ DP DVV F D S H W O R O J H R Q V S H E % L Q / K H R Q E Z D W L F  
+DT %8 +DUGHQERO - 9DLO~35 D W S Q O R Q R Y W R E U D W H I X Q F W L R Q V 9H U W H E U D W H O L I  
VLQFH WKH 7ULDVVLF 6FL \*UDGVWHLQ )0 2JJ -\* 6PLWK \$\* &RQVW  
+DT %8 +DUGHQERO - 9DLO 35 0HYRORJL D Q G W L F R J R E D O H , Q \*UDGVWHLQ  
FKURQRVWUDWLVJUDSK\ DQG HXVWDWLF FIFOH R R O R J L F L W L X H & F D O R V D P F E W L S U H + S S  
5RVV & .HQGDOO &\* 6W & HGV 6HD OYHO X K D Q J H V S O L Q W W U R L W H R U \ R I W K H (

DSSURDFK 6(30 6SHFLDO 3XEOLF DWLRQ 7XOVD a  
%DQIDOYL \* (YROXWLRQ RI RVPRO\WH +RORVOD +% F R F U H A (GXF(YROXWLRQ RI WKH  
DQG RFHQV 1DWXUH  
%DQIDOYL \* &OLPDWLF FRQVHTXH QFHV & W O R Q J W H U P O R F D O V P Q D Q W L R Q % L R J  
RI RFHQ - 0DULQH 6FL 5HV 'HYHO HVFDSH DQG WKH LUUHYHUVLEOH R[LGDW  
+DOODP \$ (DUO\ DQG PLG -XUDVVLF PROOXVFDQ ELRJRJUDSK\ DQG WKH  
HVWDEOLVKPHQW RI WKH FHQWUDO \$WODQW L F J H D Z D 3 D O H R J H R J U F P O R S R E O P R V R S  
3DODHRHFRO 6SULQJHU 6FL DQG %XVLQHVU OHGLD 'RUGU  
+DOODP \$ +DQFRFN -0 /D%UHFTXH -/ /RZU & D Q G L Q Q E S O D Q H Q W D U \ O H D N 6 F L \$ P  
-XUDVVLF WR 3DODHRJHQH 3DUW , -XUDVVLF DQG &UHWDFHRXV JHRFKURQRORJ\ DQG